IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Patent Application of: Joseph G. RADZIK	)	Confirmation No.: 5169
	)	
Application No.: 09/965,983	)	Group Art Unit: 3672
	)	
Filed: 28 September 2001	)	Examiner: Collins, G.
	)	
For: FERROUS PIPE COUPLINGS AND PRELUBRICATED COUPLING GASKETS	)	

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AMENDED APPEAL BRIEF

Sir:

This Amended Appeal Brief is being submitted in response to the Notification of Non-Compliant Appeal Brief issued October 23, 2006. In particular, this Amended Appeal Brief provides a corrected Argument Section in accordance with 37 CFR 41.37(c)(1)(vii). In accordance with MPEP Section 1205.03, this Amended Appeal Brief replaces the original appeal brief filed in connection with the above-identified matter on April 26, 2006. In addition, this Amended Appeal Brief includes the Replacement Summary of The Claimed Subject Matter Section filed on August 10, 2006. No additional fees are believed to be due for filing this amended appeal brief.

Appellant hereby appeals the final rejection of the above-identified application to the Board of Patent Appeals and Interferences.

Appellant's brief is being submitted in support of the Notice of Appeal, filed 26 January 2006, appealing to the Board of Patent Appeals and Interferences the last decision of the Examiner, i.e., a final Office Action issued 26 October 2005.

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I. REAL PARTY IN INTEREST

Central Sprinkler Corporation, a Pennsylvania corporation having a place of business at 451 North Cannon Avenue, Lansdale, Pennsylvania 19446, as the assignee of record owns the entire right, title and interest in the captioned application and, therefore, is the real party in interest.

II. RELATED APPEALS AND INTERFERENCES

Appellant is aware of no other current appeals, interferences or judicial proceedings that may be related to, directly affect or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1-23 are pending, stand finally rejected and are under appeal. A copy of the claims on appeal are appended to this brief.

IV. STATUS OF AMENDMENTS

All amendments of record have been entered.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Appellant's invention is directed generally to a pipe coupling for coupling various pipe components of ferrous pipe systems. Appellant has innovated a pipe coupling in which the elastomeric gasket member employs a powder coating which allows the gasket to be lubricated, then packaged or supplied at any point prior to installation thereby making coupling installation easier and less messy as compared to coupling installations using previously known lubricants.

There are four independent claims pending and all four are involved in the appeal. Independent claim 1 recites a lubricated ferrous pipe coupling gasket comprising a generally tubular, one-piece, elastomeric member with first and second axial open ends, the member being formed by a circumferential wall and at least a pair of circumferential flanges. Each flange extends at least generally radially inwardly at a separate one of the first and second axial open ends of the member. The circumferential wall and the pair of circumferential flanges form at least one circumferential channel on an inner circumferential side of the member. Further according to claim 1, the gasket includes a powder coating that provides a dry lubricant on at least the inner circumferential side of the pair flanges of the member.

Independent claim 1 is supported by the application as originally filed for example, shown in FIG. 2 of the application as originally filed, is an exploded view of a joint 19 made by a ferrous pipe coupling 16. *See* Appln. No. 09/965,983 as-filed at 4, lines 14-15, FIG. 2. The ferrous pipe coupling 16 includes a gasket 30. *See id.* at 4, lines 22-23. The gasket 30 is preferably a generally tubular, one-piece, elastomeric member including a circumferential wall 32 and a pair of circumferential flanges 33 and 34 located generally at first and second open axial ends 35, 36. *See id.* at 6, lines 1-3. Flanges 33 and 34 each extend at least radially inwardly. *See id* at 6, line 4. The circumferential wall 32 and the pair of flanges 33 and 34 also form a circumferential channel 38 on an inner circumferential side of the gasket 30. *See id.* at 6, lines 4-6. The gasket 30 is covered with a coating of dry cornstarch powder. *See id.* page 6, line 21 to page 7, line 1. While dry, powdered cornstarch is preferred, other dry, powdered organic starches such as rice starch and potato starch might alternatively be used. *See id.* at 8, lines 17-18. In addition, a powder predominantly or essentially composed of talc, i.e. magnesium silicate hydroxide ($Mg_3Si_4O_{10}(OH)_2$), which is the primary ingredient of conventional talcum powder, or that powder itself might be used as a dry lubricant. *See id.* at 8, lines 18-21. Corn, rice and

potato starches, being natural ingredients derived from crops, can, with other similar naturally derived starches, be referred to generically as organic starch powder. *See id.* page 8, line 21 to page 9, line 1. The lubricant can include as a primarily component, one of the aforementioned individual materials in combination with lesser amount(s) of the other(s). *See id.* at 9, lines 1-2.

Independent claim 5 recites a ferrous pipe coupling comprising a ferrous collar having an outer, axially extending, axially split circumferential wall with at least one pair of adjoining circumferential ends at the split. In addition, the coupling of independent claim 5 includes at least one fastener releasably securing together the at least one pair of adjoining, circumferential ends of the collar. Independent claim 5 recites that the coupling further comprises a gasket in the form of a generally tubular, one-piece elastomeric member positioned in the collar and having an exposed inner circumferential side exposed in the collar, the inner circumferential side having at least one flange that forms a seal with a pipe. Independent claim 5 further recites that the coupling includes a powder coating that provides a dry lubricant on at least the exposed, inner circumferential side of the elastomeric member.

Independent claim 5 is supported by the application as originally filed. For example, again referring to FIG. 2 of the application as originally filed, shown is a joint 19 made between a first piping component, pipe length 14, and a second piping component, Tee fitting 15, by one of the ferrous couplings 16. *See* Appln. No. 09/965,983 as-filed at 4, lines 14-16, FIG. 2. Ferrous pipe coupling 16 includes a split ring ferrous collar (indicated generally at 20 in FIG. 1) preferably formed by a plurality of identical ring segments 22, which are releasably secured together end to end at pairs of adjoining circumferential ends by suitable and conventional means, in this case each fastener 29 (FIG. 1). *See id.* at 4, line 16-19, FIG 2. The split ring ferrous collar 20 has an outer axially extending, split circumferential wall 24 forming a channel 28. *See id.* at 5, lines 10-15. The ferrous pipe coupling 16 further includes a gasket 30 in the form of a generally tubular, one-piece, elastomeric member positioned in the channel 28. *See id.* at 4, lines 22-23; at 5 lines 15-16. The gasket 30 is preferably a member including circumferential wall 32 and a pair of circumferential flanges 33 and 34 located generally at first and second open axial ends 35, 36, respectively, of the circumferential wall 32 and of the gasket 30. *See id.* at 6, lines 1-4. Flanges 33 and 34 each extend generally radially inward. *See id.* at 6, line 4. The circumferential wall 32 and the pair of flanges 33, 34 form a circumferential channel 38 on an inner circumferential side of the gasket 30. *See id.* at 6, lines 4-6. In use the gasket 20

is stretched over the end 14a or 15a of one of the piping components 14, 15. *See id.* at 6, lines 11-12. The stretched gasket 30 forms seals with both ends 14a, 15a of the components 14, 15 being joined. *See id.* at 6, lines 14-15. The gasket 30 is covered with a coating of dry cornstarch powder. *See id.* page 6, line 21 to page 7, line 1. While dry, powdered cornstarch is preferred, other dry, powdered organic starches such as rice starch and potato starch might alternatively be used. *See id.* at 8, lines 17-18. In addition, a powder predominantly or essentially composed of talc, i.e. magnesium silicate hydroxide ($Mg_3Si_4O_{10}(OH)_2$), which is the primary ingredient of conventional talcum powder, or that powder itself might be used as a dry lubricant. *See id.* at 8, lines 18-21. Corn, rice and potato starches, being natural ingredients derived from crops, can, with other similar naturally derived starches, be referred to generically as organic starch powder. *See id.* page 8, line 21 to page 9, line 1. The lubricant can include as a primarily component, one of the aforementioned individual materials in combination with lesser amount(s) of the other(s). *See id.* at 9, lines 1-2.

Independent claim 10 recites a ferrous piping system comprising a plurality of ferrous piping components and at least one ferrous pipe coupling mechanically and fluidly joining together ends of a pair of the piping components at a joint. Further according to independent claim 10, the ferrous pipe coupling includes a ferrous collar having an outer, axially extending and axially split, circumferential wall and at least one pair of adjoining circumferential ends at the split. The coupling further includes a gasket in the form of a generally tubular, one-piece elastomeric member having an inner circumferential side, the inner circumferential side including at least sealingly mounted on the ends of the pair of piping components and surrounded by the collar. Independent claim 10 further recites that the coupling further includes a powder coating that provides a dry lubricant at least between the at least one flange of the inner circumferential side of the gasket and the ends of the pair of piping components, and at least one fastener releasably securing together a pair of adjoining, circumferential ends of the collar so as to compress the gasket and the collar on the ends of the pair of piping components.

Independent claim 10 is supported by the application as originally filed. For example, again referring to FIG. 2 of the application as originally filed, shown is a joint 19 made between a first piping component, pipe length 14, and a second piping component, Tee fitting 15, by one of the ferrous couplings 16. *See* Appln. No. 09/965,983 as-filed at 4, lines 14-16, FIG. 2. Ferrous pipe coupling 16 includes a split ring ferrous collar (indicated generally at 20 in FIG. 1)

preferably formed by a plurality of identical ring segments 22, which are releasably secured together end to end at pairs of adjoining circumferential ends. *See id.* at 4, line 16-18, FIG. 2. The split ring ferrous collar 20 has an outer axially extending, split circumferential wall 24. *See id.* at 5, lines 10-11, FIG. 2. The ferrous pipe coupling 16 further includes a gasket 30 in the form of a generally tubular, one-piece, elastomeric member. *See id.* at 4, lines 22-23. The gasket 30 is preferably a member including circumferential wall 32 and a pair of circumferential flanges 33 and 34 located generally at first and second open axial ends 35, 36, respectively, of the circumferential wall 32 and of the gasket 30. *See id.* at 6, lines 1-4. Flanges 33 and 34 each extend generally radially inward. *See id.* at 6, line 4. The circumferential wall 32 and the pair of flanges 33, 34 form a circumferential channel 38 on an inner circumferential side of the gasket 30. *See id.* at 6, lines 4-6. In use the gasket 20 is stretched over the end 14a or 15a of one of the piping components 14, 15. *See id.* at 6, lines 11-12. The stretched gasket 30 forms seals with both ends 14a, 15a of the components 14, 15 being joined. *See id.* at 6, lines 14-15. The split ring ferrous collar 20 is then extended over and around the gasket 30. *See id.* at 6, lines 13. The gasket 30 is covered with a coating of dry cornstarch powder. *See id.* page 6, line 21 to page 7, line 1. While dry, powdered cornstarch is preferred, other dry, powdered organic starches such as rice starch and potato starch might alternatively be used. *See id.* at 8, lines 17-18. In addition, a powder predominantly or essentially composed of talc, i.e. magnesium silicate hydroxide ($Mg_3Si_4O_{10}(OH)_2$), which is the primary ingredient of conventional talcum powder, or that powder itself might be used as a dry lubricant. *See id.* at 8, lines 18-21. Corn, rice and potato starches, being natural ingredients derived from crops, can, with other similar naturally derived starches, be referred to generically as organic starch powder. *See id.* page 8, line 21 to page 9, line 1. The lubricant can include as a primarily component, one of the aforementioned individual materials in combination with lesser amount(s) of the other(s). *See id.* at 9, lines 1-2. The circumferential ends of the identical ring segments of ferrous collar 20 are releasably secured together end to end by suitable and conventional means, in this case each fastener 29 (FIG. 1). *See id.* at 4, lines 16-19.

The fourth independent claim, claim 16, recites that in a ferrous pipe coupling including a generally tubular, one-piece, elastomeric gasket having at least one flange, a ferrous collar surrounding the gasket, the collar including at least one axial split defining a pair of adjoining circumferential ends, and a fastener releasably securing together the adjoining circumferential

ends of the collar, the improvement including a powder coating that provides a dry lubricant on at least an inner circumferential side of the at least one flange of the gasket that forms a seal with a ferrous pipe.

Independent claim 16 is supported by the application as originally filed. For example, again referring to FIG. 2 of the application as originally filed, shown is a joint 19 made between a first piping component, pipe length 14, and a second piping component, Tee fitting 15, by one of the ferrous couplings 16. *See* Appln. No. 09/965,983 as-filed at 4, lines 14-16, FIG. 2. The ferrous pipe coupling 16 includes a gasket 30. *See id.* at 4, lines 22-23. The gasket 30 is preferably a member including circumferential wall 32 and a pair of circumferential flanges 33 and 34 located generally at first and second open axial ends 35, 36, respectively, of the circumferential wall 32 and of the gasket 30. *See id.* at 6, lines 1-4. Flanges 33 and 34 each extend generally radially inward. *See id.* at 6, line 4. The circumferential wall 32 and the pair of flanges 33, 34 form a circumferential channel 38 on an inner circumferential side of the gasket 30. *See id.* at 6, lines 4-6. Ferrous pipe coupling 16 includes a split ring ferrous collar (indicated generally at 20 in FIG. 1) preferably formed by a plurality of identical ring segments 22, which are releasably secured together end to end at pairs of adjoining circumferential ends. *See id.* at 4, line 16-18, FIG. 2. The circumferential ends of the identical ring segments of ferrous collar 20 are releasably secured together end to end by suitable and conventional means, in this case each fastener 29 (FIG. 1). *See id.* at 4, lines 16-19. The split ring ferrous collar 20 has an outer axially extending, split circumferential wall 24. *See id.* at 5, lines 10-11, FIG. 2. In use, the gasket 30 is stretched over the end 14a or 15a of one of the piping components 14, 15. *See id.* at 6, lines 11-12. The stretched gasket 30 forms seals with both ends 14a, 15a of the components 14, 15 being joined. *See id.* at 6, lines 14-15. The split ring ferrous collar 20 is then extended over the and around the gasket 30. *See id.* at 6, lines 13. According to the present invention, the gasket 30 or at least the inner circumferential side of the gasket 30, which is exposed to and which directly contacts the ends 14a, 15a of the joined piping components 14, 15 is covered with a coating of dry cornstarch powder. *See id.* page 6, line 21 to page 7, line 1. While dry, powdered cornstarch is preferred, other dry, powdered organic starches such as rice starch and potato starch might alternatively be used. *See id.* at 8, lines 17-18. In addition, a powder predominantly or essentially composed of talc, i.e. magnesium silicate hydroxide ($Mg_3Si_4O_{10}(OH)_2$), which is the primary ingredient of conventional talcum powder, or that

powder itself might be used as a dry lubricant. *See id.* at 8, lines 18-21. Corn, rice and potato starches, being natural ingredients derived from crops, can, with other similar naturally derived starches, be referred to generically as organic starch powder. *See id.* page 8, line 21 to page 9, line 1. The lubricant can include as a primarily component, one of the aforementioned individual materials in combination with lesser amount(s) of the other(s). *See id.* at 9, lines 1-2.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Whether claims 1, 5-6, 10, 16 and 20-23 are unpatentable under 35 U.S.C. § 103(a) over U.S. Patent No. 6,302,450 to Dole et al. ("Dole") in view of U.S. Patent No. 4,230,157 to Larsen et al. ("Larsen") and Appellant's Prior Art disclosure.

Whether claims 2-4, 7-9 and 17-19 are unpatentable under 35 U.S.C. § 103(a) over Dole in view of Larsen and Appellant's Prior Art disclosure as applied to claims 1, 5 and 16, and further in view of U.S. Patent No. 5,070,597 to Holt et al. ("Holt").

Whether claim 11 is unpatentable under 35 U.S.C. § 103(a) over Dole in view of Larsen and Appellant's Prior Art disclosure as applied to claim 10, and further in view of U.S. Patent No. 5,540,465 to Sisk ("Sisk").

Whether claim 12 is unpatentable under 35 U.S.C. § 103(a) over Dole in view of Larsen, Appellant's Prior Art disclosure and Sisk as applied to claim 11, and further in view of U.S. Patent No. 5,642,907 to Dole ("Dole '907").

Whether claims 13-15 are unpatentable under 35 U.S.C. § 103(a) over Dole in view of Larsen, Appellant's Prior Art disclosure and Sisk as applied to claim 11, and further in view of Holt.

VII. ARGUMENT

A. Claims 1, 5-6, 10, 16 and 20-23 are not obvious over Dole in view of Larsen and Appellant's Prior Art disclosure.

1. Claim 1 is not obvious over Dole in view of Larsen and Appellant's Prior Art disclosure

Independent claim 1 recites a pipe coupling that includes, *inter alia*, a tubular, one-piece, elastomeric member formed by a circumferential wall and at least a pair of circumferential flanges, and "a powder coating that provides a dry lubricant on at least the inner circumferential side of the pair of flanges." Support for these features of independent claim 1 may be found in the application as originally filed. For example, with regard to a preferred embodiment discussed in paragraph 0021, a surface coating of a powder may be applied to a gasket, such as by tumbling the gasket and the powder in an agitator. The powder coating, which tends to uniformly cover the gasket, provides a dry lubricant in an amount that is effective to lubricate the gasket during mounting over piping component ends. Because the powder coating that provides the lubricant cannot be significantly removed in the course of rubbing or handling, it can be applied at any time before installation of the gasket. Moreover, because the powder coating provides a dry lubricant, it is neither sticky nor tacky and does not attract dust, dirt or other contaminants before installation of the gasket. As discussed in paragraph 0026 of the application as originally filed, preferred powder coatings that provide a dry lubricant may include cornstarch, rice starch, potato starch, other organic starches, and talc, i.e., magnesium silicate hydroxide.

Thus, a dry lubricant that is provided by a powder coating, as recited in Appellant's independent claim 1, has a number of advantages including that a uniform covering may be achieved, inadvertent removal of the coating may be avoided, and prelubrication at any time prior to installation is possible. In contrast, gaskets that utilize an oil/grease lubricant tend to collect dirt and debris. Thus, the oil/grease lubricant is supplied separately from the gasket and then generally applied just prior to installation of the gasket. *See* paragraph 0002 of the application as originally filed.

According to the Office Action, claim 1 is rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Prior Art disclosure. Dole shows and describes a segmented, high-strength pipe coupling 10 for connecting two pipes 100 and 200. Dole's Figure 5 shows a pipe coupling 10 that has a lubricated gasket 32 with respective inner circumferential surfaces (not labeled) in contact with the exterior surface of each pipe. *See* Dole column 5, lines 22-36. As the Office Action acknowledges, Dole fails to show or describe the type of lubricant or its location on the gasket 32, and more specifically the Office Action acknowledges that, Dole fails to show or describe a powder coating that provides a dry powder lubricant.

In an attempt to cure the deficiency of Dole and reach the claimed invention, the Office Action relies on Larsen to allegedly teach that "[d]ry powder lubricant is a suitable lubricant to use in place of a grease lubricant on a gasket." However, Larsen fails to teach or suggest to one of ordinary skill in the relevant art to modify, in any way, the gasket of Dole. In particular, Larsen provides no guidance to one of ordinary skill in the art regarding gaskets and/or couplings for ferrous pipes. Moreover, Larsen fails to teach or suggest that a lubricant, whether a wet lubricant or dry lubricant, can be applied on an inner circumference of lip portion 7 of seal ring 3, which forms a seal with the outer surface of pipe 1a. Moreover, Larsen fails to teach or suggest that a powder coating of a dry lubricant can be applied.

In particular, Larsen's Figure 1 shows a pipe end portion 1 with a circumferential groove 2 on which a sealing ring 3 is constrained within the groove 2. *See* Larsen column 5, lines 26-48. The sealing ring 3 of Larsen has circumferential lip portions 6 and 7. Lubricant 9 or 9', which can be a wet lubricant or dry lubricant, is provided to facilitate movement of various lip portions 6, 7 with respect to each other as the sealing ring 3 is compressed in the groove 2 when a second pipe 1a is inserted into the first pipe 1. Larsen specifically requires the lubricant to be placed in two places: (1) between the lip portion 6 of the stiffening body (i.e., lubricant 9'), and (2) between the lip portion 6 and the groove 2 (i.e., lubricant 9), as shown in Larsen's Figure 1 of Larsen. *See* Larsen column 6, lines 7-21.

Because of the specificity of the locations on which a dry powder lubricant is to be used in Larsen, Larsen fails to provide any suggestion, motivation, or reason to combine features of Larsen with Dole so as to render the claimed invention as a whole obvious. Instead, the Office Action relies on Appellant's own specification at page 1, lines 5-6, and page 6, lines 15-20, to

allegedly suggest lubricating at least the inner surface of Dole's gasket, with the dry lubricant as allegedly taught by Larsen.

Even if Dole's gasket 32 could be modified in view of Larsen's dry lubricant, and at the location(s) allegedly suggested by Appellant's own specification, propositions that Appellant does not accept, the references would still fail to teach each and every feature of the invention as recited in independent claim 1. Specifically, Dole and Larsen fail to teach or suggest a powder coating in combination with an elastomeric member as claimed. Absent the benefit of Appellant's originally filed application, there is no suggestion or motivation to provide a powder coating. Therefore, Dole and Larsen, whether taken alone or in combination, fail to teach or suggest Appellant's invention as a whole.

Thus, for at least any of these reasons, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of independent claim 1 should be reversed, and that this claim is patentable over the applied prior art.

2. Claims 5, 6, and 21 are not obvious over Dole in view of Larsen and Appellant's Prior Art disclosure

Independent claim 5 recites a pipe coupling that includes, *inter alia*, a ferrous collar, a gasket in the form of a tubular, one-piece elastomeric member positioned in the collar and having an exposed inner circumferential side, and "a powder coating that provides a dry lubricant on at least the inner circumferential side." Support for these features of independent claim 5 may be found in the application as originally filed. For example, with regard to a preferred embodiment discussed in paragraph 0021, a surface coating of a powder may be applied to a gasket, such as by tumbling the gasket and the powder in an agitator. The powder coating, which tends to uniformly cover the gasket, provides a dry lubricant in an amount that is effective to lubricate the gasket during mounting over piping component ends. Because the powder coating that provides the lubricant cannot be significantly removed in the course of rubbing or handling, it can be applied at any time before installation of the gasket. Moreover, because the powder coating provides a dry lubricant, it is neither sticky nor tacky and does not attract dust, dirt or other contaminants before installation of the gasket. As discussed in paragraph 0026, preferred powder coatings that provide a dry lubricant may include cornstarch, rice starch, potato starch, other organic starches, and talc, i.e., magnesium silicate hydroxide.

Thus, a dry lubricant that is provided by a powder coating, as recited in Appellant's independent claim 5, has a number of advantages including that a uniform covering may be achieved, inadvertent removal of the coating may be avoided, and prelubrication at any time prior to installation is possible. In contrast, gaskets that utilize an oil/grease lubricant tend to collect dirt and debris. Thus, the oil/grease lubricant is supplied separately from the gasket and then generally applied just prior to installation of the gasket. *See* paragraph 0002 of the application as originally filed.

According to the Office Action, claim 5 is rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Prior Art disclosure. Dole shows and describes a segmented, high-strength pipe coupling 10 for connecting two pipes 100 and 200. Dole's Figure 5 shows a pipe coupling 10 that has a lubricated gasket 32 with respective inner circumferential surfaces (not labeled) in contact with the exterior surface of each pipe. *See* Dole column 5, lines 22-36. As the Office Action acknowledges, Dole fails to show or describe the type of lubricant or its location on the gasket 32. Thus, Dole fails to show or describe the combination of the collar, elastomeric member and dry powder as claimed.

In an attempt to cure the deficiency of Dole and reach Appellant's claimed invention, the Office Action relies on Larsen to allegedly teach that "[d]ry powder lubricant is a suitable lubricant to use in place of a grease lubricant on a gasket." However, Larsen fails to teach or suggest to one of ordinary skill in the relevant art to modify, in any way, the gasket of Dole. In particular, Larsen provides no guidance to one of ordinary skill in the art regarding gaskets and/or couplings for ferrous pipes. Moreover, Larsen fails to teach or suggest that a lubricant, whether a wet lubricant or dry lubricant, can be applied on an inner circumference of lip portion 7 of seal ring 3, which forms a seal with the outer surface of pipe 1a. Moreover, Larsen fails to teach or suggest that a powder coating of a dry lubricant can be applied.

In particular, Larsen's Figure 1 shows a pipe end portion 1 with a circumferential groove 2 on which a sealing ring 3 is constrained within the groove 2. *See* Larsen column 5, lines 26-48. The sealing ring 3 of Larsen has circumferential lip portions 6 and 7. Lubricant 9 or 9', which can be a wet lubricant or dry lubricant, is provided to facilitate movement of various lip portions 6, 7 with respect to each other as the sealing ring 3 is compressed in the groove 2 when a second pipe 1a is inserted into the first pipe 1. Larsen specifically requires the lubricant to be placed in

two places: (1) between the lip portion 6 of the stiffening body (i.e., lubricant 9"), and (2) between the lip portion 6 and the groove 2 (i.e., lubricant 9), as shown in Larsen's Figure 1 of Larsen. *See* Larsen column 6, lines 7-21.

Because of the specificity of the locations on which a dry powder lubricant is to be used in Larsen, Larsen fails to provide any suggestion, motivation, or reason to combine features of Larsen with Dole so as to render the claimed invention as a whole obvious. Instead, the Office Action relies on Appellant's own specification at page 1, lines 5-6, and page 6, lines 15-20, to allegedly suggest lubricating at least the inner surface of Dole's gasket, with the dry lubricant as allegedly taught by Larsen.

Even if Dole's gasket 32 could be modified in view of Larsen's dry lubricant, and at the location(s) allegedly suggested by Appellant's own specification, propositions that Appellant does not accept, the references would still fail to teach each and every feature of the invention as recited in independent claim 5. Specifically, Dole and Larsen fail to teach or suggest a powder coating. Moreover, nowhere in Dole or Larsen is it taught or suggested to combine a powder coating with a collar and elastomeric member as claimed. Thus, absent the benefit of Appellant's originally filed application, there is no suggestion or motivation to provide a powder coating. Accordingly, Dole and Larsen, whether taken alone or in combination, fail to teach or suggest Appellant's invention as a whole.

For at least any of these reasons, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of independent claim 5 should be reversed, and that this claim is patentable over the applied prior art. Moreover, claims 6 and 21 depend from independent claim 5 and are therefore also patentable for at least the same reasons, as well as for the additionally recited features that further distinguish over the applied prior art.

3. Claims 10 and 22 are not obvious over Dole in view of Larsen and Appellant's Prior Art disclosure

Independent claim 10 recites a piping system that includes, *inter alia*, a plurality of ferrous piping components and at least one ferrous pipe coupling further including a ferrous collar, a gasket in the form of a tubular one-piece elastomeric member having an inner circumferential side sealingly mounted on the ends of the pair of piping components and "a powder coating that provides a dry lubricant at least between the at least one flange of the inner

circumferential side of the gasket and the ends of the piping components." Support for these features of independent claim 10 may be found in the application as originally filed. For example, with regard to a preferred embodiment discussed in paragraph 0021, a surface coating of a powder may be applied to a gasket, such as by tumbling the gasket and the powder in an agitator. The powder coating, which tends to uniformly cover the gasket, provides a dry lubricant in an amount that is effective to lubricate the gasket during mounting over piping component ends. Because the powder coating that provides the lubricant cannot be significantly removed in the course of rubbing or handling, it can be applied at any time before installation of the gasket. Moreover, because the powder coating provides a dry lubricant, it is neither sticky nor tacky and does not attract dust, dirt or other contaminants before installation of the gasket. As discussed in paragraph 0026, preferred powder coatings that provide a dry lubricant may include cornstarch, rice starch, potato starch, other organic starches, and talc, i.e., magnesium silicate hydroxide.

Thus, a dry lubricant that is provided by a powder coating, as recited in Appellant's independent claim 10, has a number of advantages including that a uniform covering may be achieved, inadvertent removal of the coating may be avoided, and prelubrication at any time prior to installation is possible. In contrast, gaskets that utilize an oil/grease lubricant tend to collect dirt and debris. Thus, the oil/grease lubricant is supplied separately from the gasket and then generally applied just prior to installation of the gasket. *See* paragraph 0002 of the application as originally filed.

According to the Office Action, claim 10 is rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Prior Art disclosure. Dole shows and describes a segmented, high-strength pipe coupling 10 for connecting two pipes 100 and 200. Dole's Figure 5 shows a pipe coupling 10 that has a lubricated gasket 32 with respective inner circumferential surfaces (not labeled) in contact with the exterior surface of each pipe. *See* Dole column 5, lines 22-36. As the Office Action acknowledges, Dole fails to show or describe the type of lubricant or its location on the gasket 32. Thus, Dole fails to show or describe a piping system as claimed.

In an attempt to cure the deficiency of Dole and reach Appellant's claimed invention, the Office Action relies on Larsen to allegedly teach that "[d]ry powder lubricant is a suitable lubricant to use in place of a grease lubricant on a gasket." However, Larsen fails to teach or

suggest to one of ordinary skill in the relevant art to modify, in any way, the gasket of Dole. In particular, Larsen provides no guidance to one of ordinary skill in the art regarding gaskets and/or couplings for ferrous pipes. Moreover, Larsen fails to teach or suggest that a lubricant, whether a wet lubricant or dry lubricant, can be applied on an inner circumference of lip portion 7 of seal ring 3, which forms a seal with the outer surface of pipe 1a. Moreover, Larsen fails to teach or suggest that a powder coating of a dry lubricant can be applied.

In particular, Larsen's Figure 1 shows a pipe end portion 1 with a circumferential groove 2 on which a sealing ring 3 is constrained within the groove 2. *See* Larsen column 5, lines 26-48. The sealing ring 3 of Larsen has circumferential lip portions 6 and 7. Lubricant 9 or 9', which can be a wet lubricant or dry lubricant, is provided to facilitate movement of various lip portions 6, 7 with respect to each other as the sealing ring 3 is compressed in the groove 2 when a second pipe 1a is inserted into the first pipe 1. Larsen specifically requires the lubricant to be placed in two places: (1) between the lip portion 6 of the stiffening body (i.e., lubricant 9'), and (2) between the lip portion 6 and the groove 2 (i.e., lubricant 9), as shown in Larsen's Figure 1 of Larsen. *See* Larsen column 6, lines 7-21.

Because of the specificity of the locations on which a dry powder lubricant is to be used in Larsen, Larsen fails to provide any suggestion, motivation, or reason to combine features of Larsen with Dole so as to render the claimed invention as a whole obvious. Instead, the Office Action relies on Appellant's own specification at page 1, lines 5-6, and page 6, lines 15-20, to allegedly suggest lubricating at least the inner surface of Dole's gasket, with the dry lubricant as allegedly taught by Larsen.

Even if Dole's gasket 32 could be modified in view of Larsen's dry lubricant, and at the location(s) allegedly suggested by Appellant's own specification, propositions that Appellant does not accept, the references would still fail to teach each and every feature of the invention as recited in independent claim 10. Specifically, Dole and Larsen fail to teach or suggest a powder coating. Moreover, nowhere in Dole or Larsen is it taught or suggested to combine a powder coating with a plurality of ferrous piping components, a ferrous coupling and elastomeric member as claimed. Thus, absent the benefit of Appellant's originally filed application, there is no suggestion or motivation to provide a powder coating. Accordingly, Dole and Larsen, whether taken alone or in combination, fail to teach or suggest Appellant's invention as a whole.

For at least any of these reasons, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of independent claim 10 should be reversed, and that this claim is patentable over the applied prior art. Moreover, claim 22 depends from independent claim 10 and is therefore also patentable for at least the same reasons, as well as for the additionally recited features that further distinguish over the applied prior art.

4. Claims 16, 20 and 23 are not obvious over Dole in view of Larsen and Appellant's Prior Art disclosure

Independent claim 16 recites an improvement in a ferrous pipe couplings that includes, *inter alia*, an elastomeric gasket having at least one flange, a ferrous collar surrounding the gasket, and the improvement which include "a powder coating that provides a dry lubricant on at least an inner circumferential side of the at least one flange of the gasket." Support for these features of the independent claims may be found in the application as originally filed. For example, with regard to a preferred embodiment discussed in paragraph 0021, a surface coating of a powder may be applied to a gasket, such as by tumbling the gasket and the powder in an agitator. The powder coating, which tends to uniformly cover the gasket, provides a dry lubricant in an amount that is effective to lubricate the gasket during mounting over piping component ends. Because the powder coating that provides the lubricant cannot be significantly removed in the course of rubbing or handling, it can be applied at any time before installation of the gasket. Moreover, because the powder coating provides a dry lubricant, it is neither sticky nor tacky and does not attract dust, dirt or other contaminants before installation of the gasket. As discussed in paragraph 0026, preferred powder coatings that provide a dry lubricant may include cornstarch, rice starch, potato starch, other organic starches, and talc, i.e., magnesium silicate hydroxide.

Thus, a dry lubricant that is provided by a powder coating, as recited in Appellant's independent claim 16, has a number of advantages including that a uniform covering may be achieved, inadvertent removal of the coating may be avoided, and prelubrication at any time prior to installation is possible. In contrast, gaskets that utilize an oil/grease lubricant tend to collect dirt and debris. Thus, the oil/grease lubricant is supplied separately from the gasket and then generally applied just prior to installation of the gasket. *See* paragraph 0002 of the application as originally filed.

According to the Office Action, claim 16 is rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Prior Art disclosure. Dole shows and describes a segmented, high-strength pipe coupling 10 for connecting two pipes 100 and 200. Dole's Figure 5 shows a pipe coupling 10 that has a lubricated gasket 32 with respective inner circumferential surfaces (not labeled) in contact with the exterior surface of each pipe. *See* Dole column 5, lines 22-36. As the Office Action acknowledges, Dole fails to show or describe the type of lubricant or its location on the gasket 32. Thus, Dole fails to show or describe the ferrous coupling and its improvement as claimed.

In an attempt to cure the deficiency of Dole and reach Appellant's claimed invention, the Office Action relies on Larsen to allegedly teach that "[d]ry powder lubricant is a suitable lubricant to use in place of a grease lubricant on a gasket." However, Larsen fails to teach or suggest to one of ordinary skill in the relevant art to modify, in any way, the gasket of Dole. In particular, Larsen provides no guidance to one of ordinary skill in the art regarding gaskets and/or couplings for ferrous pipes. Moreover, Larsen fails to teach or suggest that a lubricant, whether a wet lubricant or dry lubricant, can be applied on an inner circumference of lip portion 7 of seal ring 3, which forms a seal with the outer surface of pipe 1a. Moreover, Larsen fails to teach or suggest that a powder coating of a dry lubricant can be applied.

In particular, Larsen's Figure 1 shows a pipe end portion 1 with a circumferential groove 2 on which a sealing ring 3 is constrained within the groove 2. *See* Larsen column 5, lines 26-48. The sealing ring 3 of Larsen has circumferential lip portions 6 and 7. Lubricant 9 or 9', which can be a wet lubricant or dry lubricant, is provided to facilitate movement of various lip portions 6, 7 with respect to each other as the sealing ring 3 is compressed in the groove 2 when a second pipe 1a is inserted into the first pipe 1. Larsen specifically requires the lubricant to be placed in two places: (1) between the lip portion 6 of the stiffening body (i.e., lubricant 9'), and (2) between the lip portion 6 and the groove 2 (i.e., lubricant 9), as shown in Larsen's Figure 1 of Larsen. *See* Larsen column 6, lines 7-21.

Because of the specificity of the locations on which a dry powder lubricant is to be used in Larsen, Larsen fails to provide any suggestion, motivation, or reason to combine features of Larsen with Dole so as to render the claimed invention as a whole obvious. Instead, the Office Action relies on Appellant's own specification at page 1, lines 5-6, and page 6, lines 15-20, to

allegedly suggest lubricating at least the inner surface of Dole's gasket, with the dry lubricant as allegedly taught by Larsen.

Even if Dole's gasket 32 could be modified in view of Larsen's dry lubricant, and at the location(s) allegedly suggested by Appellant's own specification, propositions that Appellant does not accept, the references would still fail to teach each and every feature of the invention as recited in independent claim 16. Specifically, Dole and Larsen fail to teach or suggest a powder coating. Absent the benefit of Appellant's originally filed application, there is no suggestion or motivation to provide a powder coating. Thus, Dole and Larsen, whether taken alone or in combination, fail to teach or suggest a ferrous coupling and an improvement thereof as claimed and therefore further fail to teach Appellant's invention as a whole.

For at least any of these reasons, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of independent claim 16 should be reversed, and that this claim is patentable over the applied prior art. Moreover, claims 20 and 23 depend, directly or indirectly, from independent claim 16 and are therefore also patentable for at least the same reasons, as well as for the additionally recited features that further distinguish over the applied prior art.

B. Claims 2-4, 7-9 and 17-19 are not obvious over Dole in view of Larsen and Appellant's Prior Art disclosure, and further in view of Holt

According to the Office Action, claims 2-4, 7-9 and 17-19 stand rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Prior Art disclosure as applied to claims 1, 5 and 16 and further in view of Holt. Holt however fails to cure the deficiencies in the proposed combination of Dole in view of Larsen and Appellant's own disclosure as discussed above. Specifically, Holt fails to teach or suggest, at the time the invention was made, a powder coating that provides a dry lubricant on at least the inner circumferential surface of the gasket so as to cure the above-noted deficiencies of Dole in view of Larsen.

Holt shows an elastomeric double-walled tube 1 to connect two pipes 22 together. Holt states that the double walled tube 1 is provided with friction reducing means 4 disposed between the walls. *See* Holt column 8, lines 57-66. Holt's friction reducing means 4 can be of a solid, semi-solid, or liquid lubricant. *See* Holt column 9, lines 26-28, column 12, lines 1-18 and 65-68,

and column 13, lines 3-15. However, Holt is completely silent as to a powder coating of the friction reducing means 4.

Thus, for at least any of these reasons, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of claims 2-4, 7-9 and 17 -19 should be reversed, and that these claims are patentable over the applied prior art.

C. Claim 11 is not obvious over Dole in view of Larsen and Appellant's Disclosure as applied to claim 10, and further in view of Sisk

According to the Office Action, claim 11 stands rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Disclosure as applied to claim 10, and further in view of Sisk. Sisk however fails to cure the deficiencies in the proposed combination of Dole in view of Larsen and Appellant's own disclosure as discussed above. Specifically, Sisk fails to teach or suggest, at the time the invention was made, a powder coating that provides a dry lubricant on at least the inner circumferential surface of the gasket so as to cure the above-noted deficiencies of Dole in view of Larsen.

Sisk shows and describes a pipe coupler 30 with clamping arms 32 and 34 for a gasket 150. *See* Sisk column 4, lines 54-64, and column 5, lines 9-21. Sisk, however, fails to show or describe any lubricant anywhere on the gasket 150. Consequently, Sisk fails to teach or suggest a powder coating such that Sisk would cure the deficiencies of Dole in view of Larsen.

Thus, for at least any of these reasons, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of claim 11 should be reversed, and that this claim is patentable over the applied prior art.

D. Claim 12 is not obvious over Dole in view of Larsen and Appellant's Prior Art disclosure as applied to claim 11, and further in view of Dole '907

According to the Office Action, claim 12 stands rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Disclosure and Sisk as applied to claim 11, and further in view of Dole '907. Dole '907 fails to cure the deficiencies in the proposed combination of Dole in view of Larsen and Appellant's own disclosure. Specifically, Dole '907 fails to teach or suggest, at the time the invention was made, a powder coating that provides a dry lubricant on at least the inner circumferential surface of the gasket so as to cure the above-noted deficiencies of Dole in view of Larsen.

Dole '907 shows and describes an end fitting 10 with an elastomeric seal 18. *See* Dole '907 column 4, lines 24-31. Dole '907, however, fails to show or describe any type of lubricant anywhere on the seal 18. Consequently, Dole '907 fails to teach or suggest a powder coating such that Dole '907 would cure the deficiencies of Dole in view of Larsen and Sisk. Accordingly, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of claim 12 should be withdrawn, and that this claim is allowable over the applied prior art.

E. Claims 13-15 are not obvious over Dole in view of Larsen and Appellant's Disclosure and Sisk as applied to claim 11, and further in view of Holt

According to the Office Action, claims 13-15 stand rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over Dole in view of Larsen and the Appellant's Disclosure and Sisk as applied to claim 11, and further in view of Holt. As previously discussed, Sisk and Holt fail to cure the deficiencies in the proposed combination of Dole in view of Larsen and Appellant's own disclosure. Specifically, Sisk and Holt fail to teach or suggest, at the time the invention was made, a powder coating that provides a dry lubricant on at least the inner circumferential surface of the gasket so as to cure the above-noted deficiencies of Dole in view of Larsen.

Sisk shows and describes a pipe coupler 30 with clamping arms 32 and 34 for a gasket 150. *See* Sisk column 4, lines 54-64, and column 5, lines 9-21. Sisk, however, fails to show or describe any lubricant anywhere on the gasket 150. Consequently, Sisk fails to teach or suggest a powder coating such that Sisk would cure the deficiencies of Dole in view of Larsen.

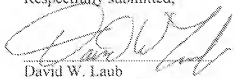
Holt's shows an elastomeric double-walled tube 1 to connect two pipes 22 together. Holt states that the double walled tube 1 is provided with friction reducing means 4 disposed between the walls. *See* Holt column 8, lines 57-66. Holt's friction reducing means 4 can be of a solid, semi-solid, or liquid lubricant. *See* Holt column 9, lines 26-28, column 12, lines 1-18 and 65-68, and column 13, lines 3-15. However, Holt is completely silent as to a powder coating of the friction reducing means 4.

Thus, for at least any of these reasons, it is respectfully submitted that the rejection under 35 U.S.C. § 103(a) of claims 13-15 should be reversed, and that these claims are patentable over the applied prior art.

* * *

In view of the above arguments and evidence of record, Appellant respectfully requests the Board to reverse the rejection of claims 1-23.

Respectfully submitted,



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VIII. CLAIMS APPENDIX

1. A lubricated ferrous pipe coupling gasket comprising:

a generally tubular, one-piece, elastomeric member with first and second axial open ends, the member being formed by a circumferential wall and at least a pair of circumferential flanges, each flange extending at least generally radially inwardly at a separate one of the first and second axial open ends of the member, the circumferential wall and the pair of circumferential flanges forming at least one circumferential channel on an inner circumferential side of the member; and

a powder coating that provides a dry lubricant on at least the inner circumferential side of the pair flanges of the member.

2. The gasket of claim 1 wherein the dry lubricant comprises an organic starch powder.

3. The gasket of claim 1 wherein the dry lubricant consists essentially of organic starch powder.

4. The gasket of claim 1 wherein the dry lubricant is selected from the group consisting of cornstarch, rice starch, potato starch, talc and magnesium silicate hydroxide.

5. A ferrous pipe coupling comprising:

a ferrous collar having an outer, axially extending, axially split circumferential wall with at least one pair of adjoining circumferential ends at the split;

at least one fastener releasably securing together the at least one pair of adjoining, circumferential ends of the collar;

a gasket in the form of a generally tubular, one-piece elastomeric member positioned in the collar and having an exposed inner circumferential side exposed in the collar, the inner circumferential side having at least one flange that forms a seal with a pipe; and

a powder coating that provides a dry lubricant on at least the exposed, inner circumferential side of the elastomeric member.

6. The ferrous pipe coupling of claim 5 wherein the ferrous collar includes a pair of at least generally radially inwardly extending circumferential flanges, each flange being located at a

separate axial end of the circumferential wall, the pair of flanges and the circumferential wall forming a circumferential channel on an inner circumferential side of the collar and wherein the gasket is positioned in the channel.

7. The coupling of claim 5 wherein the dry lubricant comprises an organic starch powder.

8. The coupling of claim 5 wherein the dry lubricant consists essentially of organic starch powder.

9. The coupling of claim 5 wherein the dry lubricant is selected from the group consisting of cornstarch, rice starch, potato starch, talc and magnesium silicate hydroxide.

10. A ferrous piping system comprising:

a plurality of ferrous piping components; and

at least one ferrous pipe coupling mechanically and fluidly joining together ends of a pair of the piping components at a joint, the ferrous pipe coupling including:

a ferrous collar having an outer, axially extending and axially split, circumferential wall and at least one pair of adjoining circumferential ends at the split;

a gasket in the form of a generally tubular, one-piece elastomeric member having an inner circumferential side, the inner circumferential side including at least sealingly mounted on the ends of the pair of piping components and surrounded by the collar;

a powder coating that provides a dry lubricant at least between the at least one flange of the inner circumferential side of the gasket and the ends of the pair of piping components; and

at least one fastener releasably securing together a pair of adjoining, circumferential ends of the collar so as to compress the gasket and the collar on the ends of the pair of piping components.

11. The ferrous piping system of claim 10 further comprising:

a one-way valve coupled with the plurality of piping components a potable water supply, the valve being arranged to supply water from the potable water supply to the plurality piping components.

12. The ferrous piping system of claim 11, wherein one of the plurality of piping components is a fitting and further comprising a fire sprinkler coupled with the fitting to be supplied with water by the potable water source through the piping system.

13. The ferrous piping system of claim 11 wherein the dry lubricant comprises an organic starch powder.

14. The ferrous piping system of claim 11 wherein the dry lubricant consists essentially of organic starch powder.

15. The ferrous piping system of claim 11 wherein the dry lubricant is selected from the group consisting of one of cornstarch, rice starch, potato starch, talc and magnesium silicate hydroxide.

16. In a ferrous pipe coupling including a generally tubular, one-piece, elastomeric gasket having at least one flange, a ferrous collar surrounding the gasket, the collar including at least one axial split defining a pair of adjoining circumferential ends, and a fastener releasably securing together the adjoining circumferential ends of the collar, the improvement including a powder coating that provides a dry lubricant on at least an inner circumferential side of the at least one flange of the gasket that forms a seal with a ferrous pipe.

17. The improvement of claim 16 wherein the dry lubricant comprises an organic starch powder.

18. The improvement of claim 16 wherein the dry lubricant consists essentially of organic starch powder.

19. The improvement of claim 16 wherein the dry lubricant is selected from the group consisting of cornstarch, rice starch, potato starch, talc and magnesium silicate hydroxide.

20. The improvement of claim 16 wherein the dry lubricant coats all circumferential surfaces of the gasket.

21. The ferrous pipe coupling of claim 5, wherein the gasket comprises a pair of circumferential flanges formed on the exposed inner circumferential side of the gasket.

22. The ferrous pipe system of claim 10, wherein the gasket comprises a pair of circumferential flanges formed on the inner circumferential side of the gasket.

23. The improvement of claim 20, wherein the dry lubricant coats a pair of flanges formed on the circumferential surface of the gasket.

IX. EVIDENCE APPENDIX

The following is a list of references entered by the Examiner and/or relied upon by Appellant in this appeal, along with a statement setting forth where in the record that evidence was entered by the examiner and/or the appellant. Copies of each piece of evidence are provided herewith.

Reference	Location in the Record
1. Schultz et al (U.S. Patent No. 6,371,491).	Appellant's Amendment and Request for Reconsideration Under 37 C.F.R. § 1.111, filed 8 August 2005, page 6, lines 11-27; Information Disclosure Statement, filed 26 November 2002.
2. Dole et al (U.S. Patent No. 6,302,450)	Final Office Action issued 26 October 2005 (pages 2-7); Information Disclosure Statement, filed 17 July 2002.
3. Larsen et al. (U.S. Patent No. 4,230,157)	Final Office Action issued 26 October 2005 (pages 2-7); Information Disclosure Statement, filed 17 July 2002.
4. Appellant's Prior Art disclosure	Final Office Action issued 26 October 2005 (pages 2-7); Information Disclosure Statement, filed 26 February 2002.
5. Holt et al. (U.S. Patent No. 5,070,597)	Final Office Action issued 26 October 2005 (page 7); Information Disclosure Statement, filed 26 February 2002.
6. Sisk (U.S. Patent No. 5,540,465)	Final Office Action issued 26 October 2005 (pages 8); Information Disclosure Statement, filed 17 July 2002.
7. Dole (U.S. Patent No. 5,642,907)	Final Office Action issued 26 October 2005 (pages 8); Information Disclosure Statement, filed 17 July 2002.

X. RELATED PROCEEDINGS APPENDIX

None

Reference 1

US006371491B1

(12) **United States Patent**
Schultz et al.

(10) **Patent No.: US 6,371,491 B1**
(45) **Date of Patent: Apr. 16, 2002**

(54) **PIPE FITTING GASKET HAVING ENHANCED SURFACE PROPERTIES**

(75) Inventors: **Charles W. Schultz**, Easton, PA (US); **Lawrence W. Thau, Jr.**, Flemington, NJ (US)

(73) Assignee: **Victaulic Company of America**, Easton, PA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/399,834**

(22) Filed: **Sep. 21, 1999**

(51) **Int. Cl.**[7] **F16L 17/035**

(52) **U.S. Cl.** 277/627; 277/652; 277/936; 285/112; 285/373

(58) **Field of Search** 277/627, 650, 277/652, 935, 936, 938, 944; 285/112, 373

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Primary Examiner—Anthony Knight
Assistant Examiner—John L. Beres
(74) *Attorney, Agent, or Firm*—Abelman, Frayne & Schwab

(57) **ABSTRACT**

An elastomeric gasket for a pipe coupling having a dry lubricating film of an aqueous solution of a lubricant and a film-forming polymer adhered thereto.

10 Claims, 1 Drawing Sheet

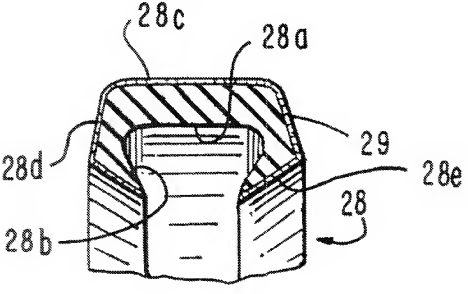

FIG. 1

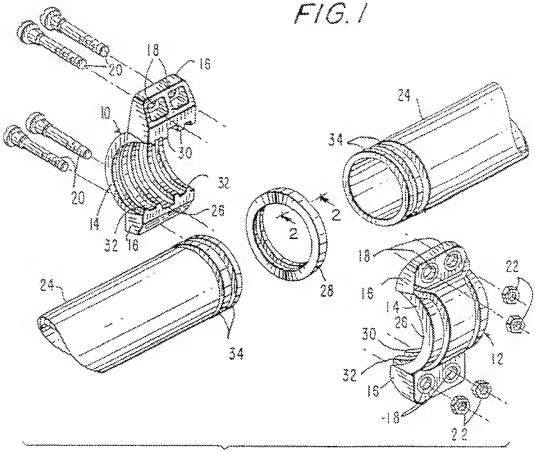
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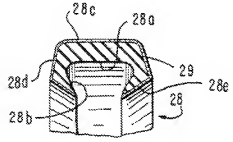
FIG. 2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PIPE FITTING GASKET HAVING ENHANCED SURFACE PROPERTIES

The present invention relates to a gasket having a dry lubricant and, more particularly, to an elastomeric gasket for use in any system using an elastomeric gasket, for example, pipe couplings. The benefits of the present invention may be beneficially applied to any system in which a dry lubricant can be used to assist gasket seating and emplacement.

BACKGROUND OF THE INVENTION

Numerous types of systems use gaskets to prevent leakage. For example, pipe couplings are known which are intended to economically and efficiently provide secure, leakproof connection at the juncture of a variety of pipe configurations. The particular coupling assembly selected naturally depends upon the type of pipes being connected, their routing, and their sizes, and the intended service for which they will be used.

Typical of such pipe couplings, to which the present invention has found particularly advantageous utilization, are the (i) groove pipe couplings as typically shown in the U.S. Pat. No. 6,021,495, (ii) the T couplings for branch pipes to be secured to a main pipe, as typically shown in U.S. Pat. No. 3,999,785, (iii) the cam actuated couplings, as typically shown in U.S. Pat. No. 4,165,892, and (iv) the boltless locking pin secured couplings as typically shown in U.S. Pat. No. 4,561,678, all of which are assigned to the assignee of the present invention and the disclosures of which are incorporated herein by reference.

While differing in construction and application, one common feature of all such couplings, as well as other coupling constructions to which the present invention is applicable, is the inclusion of a deformable gasket, which is typically constructed of an elastomeric compound, such as natural or synthetic rubber. The gasket is contained within a suitably configured recess and is employed to seal the pipes meeting at the coupling, to prevent leakage when the coupling is in an assembled condition.

Typically, when the various components of the coupling, including the gasket, are shipped to the installation site, the gasket is exposed to the environment. It has been found that during shipping, dust, or other contaminants, such as paint chipping off of the coupling segments, may stick to the gasket. At the site, the installer must then remove, clean, and lubricate the gasket during the process of installing the coupling joint onto the pipe.

In addition to the inefficiency of having to clean the gasket at the installation site, the polymeric water-based lubricants or the silicone-based lubricants which are currently applied to the gasket surfaces in the "wet state" at the installation site, tend to run, seem and, in general, leave an unsightly and unsafe residue. In many instances, the installer may either place a non-uniform or uneven quantity of lubricant, or even the wrong lubricant, on the gasket. This can ultimately result in leakage due to an improper gasket seat, as well as damaging the gasket and materially shortening its useful life. Safety can also be compromised by virtue of the slippery residue being transferred to tools, surfaces, and body parts.

Accordingly, it is an object of the present invention to provide a pipe coupling gasket having a dry lubricant in the form of a dry film bonded thereto.

It is another object of the present invention to minimize exposure of the gasket to oxidative effects by the encapsulating and permeability characteristics of the surface treatment.

It is a further object of the present invention to pre-lubricate an elastomeric gasket when it is manufactured by applying a lubricating film to its surfaces and which is in a dry condition during shipment and installation in a pipe coupling at a pipe assembly site.

It is still a further object of the present invention to provide an elastomeric gasket or seal, ready for installation in a pipe coupling, having pre-lubricated surfaces which are in a dry state.

It is yet a further object of the present invention to provide an elastomeric gasket or seal having a pre-lubricated dry surface which is colored or dyed to denote and verify the presence and coverage of the lubricant or its service rating.

These as well as other objects will become apparent upon review of the following drawing and detailed description which follows.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded perspective view of one form of a segmented pipe coupling intended to utilize the gasket of the present invention.

FIG. 2 is an enlarged sectional view taken along the line 2—2 of the gasket of FIG. 1.

SUMMARY OF THE INVENTION

It has now been found that the problems associated with applying a paste or liquid gasket lubricant in the wet state at, for example, a pipe installation site, to insure an adequate seal can be overcome by applying an aqueous solution of a lubricant and a film-forming polymer evenly and uniformly to the surface of the elastomeric gasket after its manufacture. By this means, the gasket has a uniform lubricating film on its surface in the dried state which allows the gasket to be shipped and installed without being concerned about encountering the uncertainties and problems attendant to and inherent in, the application on-site of liquid lubricants. Furthermore, by applying the lubricant composition of the present invention in a uniform manner in accordance with the process of the present invention on the gasket surfaces, significant benefits are realized, viz., exposure of the gasket to oxidation is reduced, a tighter and more effective seal is achieved, the useful life of the gasket is extended, and workplace safety is significantly improved since the installers do not have to handle slippery and dangerous metal parts, as is the case when using conventional lubricants.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides an elastomeric gasket or seal, for use in sealing devices designed to make a pressure-tight joint between stationary parts to prevent the leakage of liquids and fluids, which has a dry lubricating film adhered to its surface.

The present invention finds particular application with respect to gaskets used in pipe couplings for grooved pipe. The solid, dry lubricating film provides continuous and uniform lubrication so that the coupling sides easily, gasket pinching is prevented and ready rotation of the coupling is facilitated.

Referring to FIG. 1, there is depicted one form of a segmented pipe coupling intended for grooved pipe and which includes the gasket of the present invention having a dry lubricant film adhered to its surface. This coupling is of the type which is the subject of the aforementioned U.S. Pat. No. 4,601,495.

The segmented coupling of FIG. 1 is illustrated in disassembled condition, with the respective coupling segments being indicated at **10** and **12**. The coupling segments are identical with each other and are substantially semi-circular in form, each coupling member half being comprised by an arcuate body portion **14** which terminates at its ends in radially outwardly extending bolting pads **16** formed integrally with the body portion **14**.

Each of the radially outwardly extending bolting pads **16** includes apertures **18** for the reception of fastening members, which, in the drawing, are shown as headed bolts **20**. When in an assembled condition, the respective coupling segments **10** and **12** are secured to each other in encircling relationship with the pipe ends by the headed bolts **20** and conventional nuts or lock nuts **22** threadedly received on the bolts.

Internally of each coupling segment half **10** and **12** and intermediate the axial length thereof in the embodiment illustrated, is a recess **26** in which a gasket **28** is accommodated, having a dry lubricating film **29** bonded thereto in accordance with the present invention, the gasket **28** being employed to seal the pipes **24** when the coupling is in an assembled condition and prevent leakage.

Located immediately adjacent the recess **26** in each coupling segment is an axially inner key **30** formed integrally with the coupling segment, and, spaced from each of the axially inner keys **30** are axially outer keys **32**, which similarly are formed integrally with the respective coupling segments. Although two keys **30** and **32** are shown in this embodiment, the invention may also be used in similar grooved pipe couplings intended for lower pressure applications which may include only a single key for each pipe.

The respective keys **30** and **32** are dimensioned, as later discussed, for them to be received within corresponding axially spaced annular grooves **34** formed in the respective pipes adjacent the ends thereof.

To install the segmented coupling, the ends of the pipes **24** are brought into proximity with each other with the gasket **28** in sealing relationship with the pipe ends. The respective coupling segments are positioned over the gasket **28** with the gasket contained within the recess **26**, and the keys **30** and **32** are inserted into the annular grooves **34** in the respective pipe ends. The bolts **20** are then inserted through the aligned apertures **18** of the coupling segments, and the coupling segments are drawn towards each other by tightening the nuts **22** down on the bolts **20**. This draws the respective coupling segments towards the pipes, and compresses the gasket **28** into intimate sealing contact with the respective pipe ends.

While the respective coupling segments may be formed by any known techniques, such as by pressing or drop-forging steel or any other suitable high-strength metal, the respective coupling segments are formed by close tolerance casting techniques from ductile iron or a similar high-strength metal.

While the segmented coupling illustrated in the drawing is comprised of only two coupling segments, it will be appreciated that the invention is equally applicable to segmented couplings comprising three or more coupling segments for use in conjunction with large diameter pipes. The use of multiple coupling segments facilitates the manual handling of the segments and the assembly of the coupling onto the pipes. Additionally, the formation of such large size segmented couplings from multiple coupling segments facilitates the forming of the respective coupling segments to closer tolerances than would be possible in the case of a large segmented coupling comprised of only two coupling segments.

As can be seen by reference to FIG. **2**, the inner surface of gasket **28**, when viewed in cross-section, defines a substantially U-shaped channel having a flat upper surface **28***a* which merges into inwardly inclined inner lips **28***b*. The outer surface of gasket **28** includes a flat upper surface **28***d* which merges into downwardly and outwardly extending sidewalls **28***d* and then into downwardly and inwardly extending outer lips **28***e*. While the lubricating composition of the present invention has been found to be safe even in contact with potable water, it is preferred that only the outer surfaces of the gasket, namely upper surface **28***C*, sidewalls **28***d* and outer lips **28***e*, have the lubricating film **29** applied thereto. This is felt to provide an extra measure of environmental safety to insure that the dry lubricating film never comes into contact with the liquid being carried through the coupled pipes.

The gasket lubricant of the present invention comprises a lubricant in a film-forming polymer which holds and maintains the lubricant on the surface of the elastomeric gasket at least sufficiently so as to be substantially in situ during the installation stage. This type of lubricant system allows for a longer life span than that typically obtainable by the use of conventional lubricant systems.

The elastomeric gaskets which can be used in accordance with the present invention are typically made from various synthetic rubbers. Exemplary elastomeric gaskets can be made from EPDM, nitrile rubber, epichlorohydrin, neoprene, silicone and halogenated butyl rubber.

The lubricant employed in the present invention is an aqueous suspension of graphite, soaps or a natural or synthetic wax dispersed in a film-forming polymer, with waxes being preferred.

Suitable waxes include natural waxes, such as beeswax, spermaceti, carnauba wax, candelilla wax, montan wax, ozocerite wax (ceresin wax), microcrystalline waxes, paraffin waxes and petrolatum waxes, amongst others; and synthetic waxes, such as long-chain polymers of ethylene, long-chain polymers of ethylene oxide combined with a dihydric alcohol, e.g. polyoxyethylene glycol ("Carbowax"), chlorinated naphthalenes ("Halowaxes"), waxy polyol ether-esters, e.g., polyoxyethylene sorbitol, synthetic hydrocarbon waxes (Fischer-Tropsch waxes), straight-chain wax-like ketones, e.g., laurone, palmitone and stearone, and cyclic ketones, e.g., phenoxyphenyl heptadecyl ketone, amide derivatives of fatty acids, polysiloxane waxes, polyoxyethylene fatty acid esters (e.g., "Carbowax 4000 (Mono) Stearate"), amongst others. Paraffin waxes are especially preferred due to their ready availability.

The lubricant, e.g. wax, is dispersed in an effective film-forming amount of a water-insoluble polymer comprising an ether of a polypropylene glycol. Preferred polypropylene glycol ethers for use in the practice of the present invention are monoalkyl ethers of tripropylene glycol, with the use of tripropylene glycol monomethyl ether being particularly preferred.

While polytetrafluoroethylene (PTFE) does not form an intimate and enduring a bond with the elastomeric gasket of the present invention, when compared with polypropylene glycol ethers, it, too, can be used to advantage to deliver and retain the lubricant on the surfaces of the gasket, albeit for a shorter period of time. An intimate bonding of the lubricant film is not required inasmuch as the primary purpose in lubrication where coating displacement in the installation phase and post-installation may enhance performance.

A lubricating film of the present invention is applied to the gaskets after their manufacture by any of a variety of

conventional application methods including spraying, fogging, dipping, sponging, painting, etc. However, it has been found that in order to obtain a uniform and consistent film coating of about 1 mil in thickness, it is preferable to apply the lubricant by means of high volume, low pressure (HVLP) spraying equipment. Uniform application is insured by placing the gaskets on a positioning belt and then employing a plurality of spray nozzles which emit an airborne mist which can apply a 1 mil film coating. Thereafter, in order to insure that the wax containing polymeric film is properly dried, air is directed at the gaskets having a wet film on their surface.

Thereafter, the gaskets are removed from the belt and can be dried still further by heated air to complete the drying process. Completion of the curing of the polymer and its bonding to the elastomeric gasket in the form of a dry bonded film can be achieved by maintaining the gasket at ambient temperature for about 14 days. Curing and bonding can be accelerated, if desired, by subjecting the partially dried film to a temperature of about 150° F. for about 20 to about 35 minutes which is sufficient to complete the curing of the polymer.

While the gaskets in accordance with the present invention can be shipped to the installation site without need of further protection, it may be advantageous to package them in a protective environment, such as a clear plastic shrink wrap which is the subject of parent application Ser. No. 09/162,954, filed Sep. 29, 1998, the disclosure of which is incorporated herein by reference and which is assigned to the assignee of the present invention.

It has also been determined that FDA approved dyes and pigments can safely and effectively be added to the lubricant in order to color-code the gaskets so that the nature of the elastomer employed in the gasket can be readily identified. For instance, a yellow dye might be used to identify a gasket made with nitrile rubber, while a blue dye might be used to identify a gasket made with EPDM. Alternatively, the colorant in the lubricant could also function to denote the service rating of the gasket, i.e., green, for example, would signify gaskets having high temperature applications, while red would denote gaskets designed for use at low temperatures.

Elastomeric gaskets having a dry lubricating film deposited thereon in accordance with the present invention are, once they are dried, stable in water. It has been determined that pre-lubricated gaskets in accordance with the present invention meet NSF Standard 14 as being completely safe for the passage of potable water through pipes coupled with such gaskets. Further, once the lubricant is applied to the gasket, it will not run or seep out, as is the case with conventional gasket lubricants. Thus, plant personnel are provided with visible assurance and a high level of confidence that the gaskets are functioning properly and are providing sustained and continuous lubrication.

EXAMPLE

Once a positioning belt holding elastomeric gaskets made from nitrile rubber there was discharged from multiple spray nozzles maintained at a constant pressure an air-borne wet mist of a lubricant identified as EXP W 122 U made by Coatings for Industry, Inc. of Souderton, Pa., sufficient to apply a uniform one (1) mil wet coating onto the surface of each gasket. The gaskets were initially dried with air jets at ambient temperature. Thereafter, the gaskets were allowed to dry at ambient temperature for 14 days to complete the curing of the lubricating film to the surface of the gaskets.

What is claimed is:

1. A pipe coupling for surrounding a pipe in sealed engagement therewith, said pipe coupling comprising a body having an annular configuration which defines an internal gasket seat for receiving an annular shaped elastomeric gasket configured and dimensioned for cooperative engagement with said internal gasket seat, said elastomeric gasket having an inner surface and an outer surface, said inner gasket surface defining in cross section a generally U-shaped channel having a substantially flat upper peripheral surface portion (28*a*) and inwardly and downwardly inclined inner lip portions (28*b*) extending therefrom, said outer gasket surface defining in cross section a generally flat upper peripheral surface portion (28*c*), generally downwardly and outwardly extending side wall portions (28*d*), and generally downwardly and inwardly extending outer lip portions (28*e*), a dry lubricating film comprising a lubricant in a film-forming polymer adhered only to said outer surface portions of said gasket, said inner surface portions of said gasket being devoid of said film-forming polymer.

2. The pipe coupling of claim 1 wherein the lubricant is selected from the group consisting of graphite, soaps and natural or synthetic waxes.

3. The pipe coupling of claim 1 wherein the wax is selected from the group consisting of paraffine waxes, ethylenic polymeric waxes, chlorinated naphthalene and microcrystalline waxes.

4. The pipe coupling of claim 1 wherein the elastomer forming the elastomeric gasket is selected from the group consisting of EPDM, nitrile rubber, epichlorohydrin, neoprene, silicone rubber and halogenated butyl rubber.

5. The pipe coupling of claim 1 wherein the film-forming polymer is a polypropylene glycol ether.

6. A sealing device for providing a fluid pressure-tight joint between stationary parts, which comprises,

(a) an annular-shaped elastomeric gasket having an inner surface and an outer surface,

(b) said inner gasket surface defining in cross-section a generally U-shaped channel having a substantially flat upper peripheral surface portion (28*a*) and inwardly and downwardly extending inner lip portions (28*b*) extending therefrom.

(c) said outer gasket surface defining in cross-section a generally flat upper peripheral surface (28*c*), generally downwardly and outwardly extending side wall portions (28*d*), and generally downwardly and inwardly extending outer lip portions (28*e*),

(d) a dry lubricating film (29) comprised of a lubricant and a film-forming polymer adhered only to the outer surface portions of said gasket, said inner surface portions of said gasket being devoid of said film-forming polymer.

7. The sealing device of claim 6 wherein the lubricant is selected from the group consisting of graphite, soaps and natural or synthetic waxes.

8. The sealing device of claim 6 wherein the wax is selected from the group consisting of paraffine waxes, ethylene polymeric waxes, chlorinated naphthalene and microcrystalline waxes.

9. The sealing device of claim 6 wherein the film-forming polymer is a polypropylene glycol ether.

10. The sealing device of claim 6 wherein the elastomeric gasket is positioned within a pipe coupling at the juncture of two pipe ends.

* * * * *

Reference 2

US006302450B1

(12) **United States Patent**
Dole et al.

(10) **Patent No.: US 6,302,450 B1**
(45) **Date of Patent: Oct. 16, 2001**

(54) **COUPLING FOR PLAIN END PIPE**

(75) Inventors: **Douglas R. Dole**, Whitehouse Station, NJ (US); **Charles W. Shultz**, Easton, PA (US)

(73) Assignee: **Victaulic Company of America**, Easton, PA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/177,987**

(22) Filed: **Oct. 22, 1998**

(51) Int. Cl.[7] **F16L 25/00**

(52) U.S. Cl. **285/328**; 285/373; 285/112

(58) Field of Search 285/112, 373, 285/419, 328, 340, 423

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Primary Examiner—Teri Pham Luu
(74) *Attorney, Agent, or Firm*—Abelman, Frayne & Schwab

(57) **ABSTRACT**

A segmented pipe coupling is disclosed which includes a successive series of circumferentially discontinuous teeth which extend radially inward along the interior arcuate surface of the coupling and are intended to securely engage a plain ended pipe without cutting into the pipe exterior. The teeth are preferably formed by superimposed multi-lead right hand and left hand threads along the inner arcuate portion of the segmented pipe coupling.

22 Claims, 8 Drawing Sheets

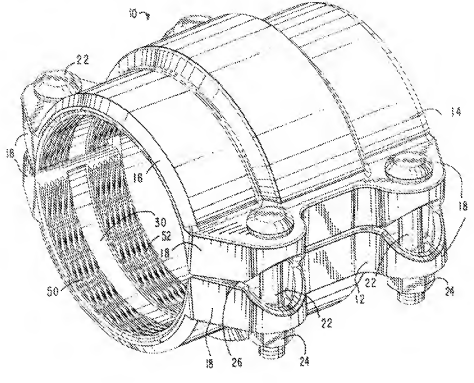


FIG. 1

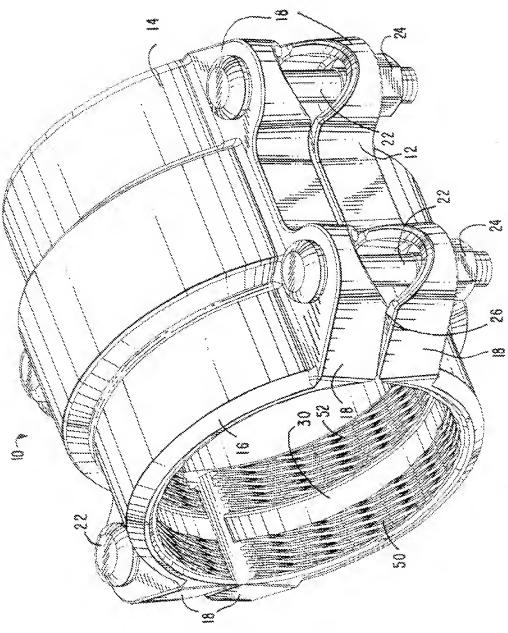


FIG. 2

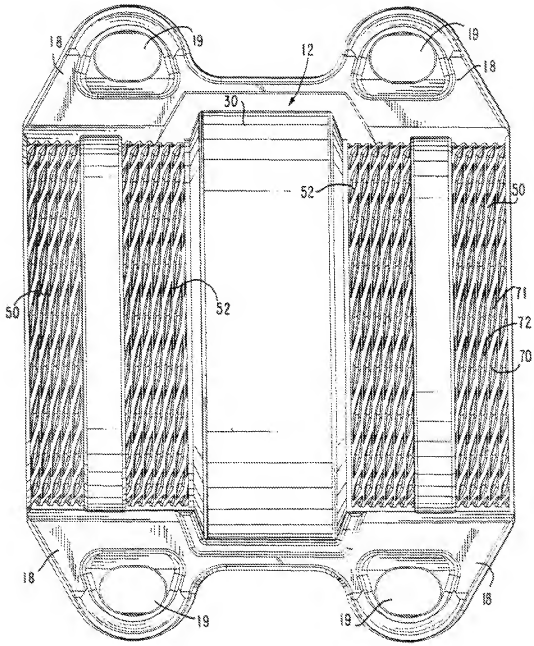


FIG. 3

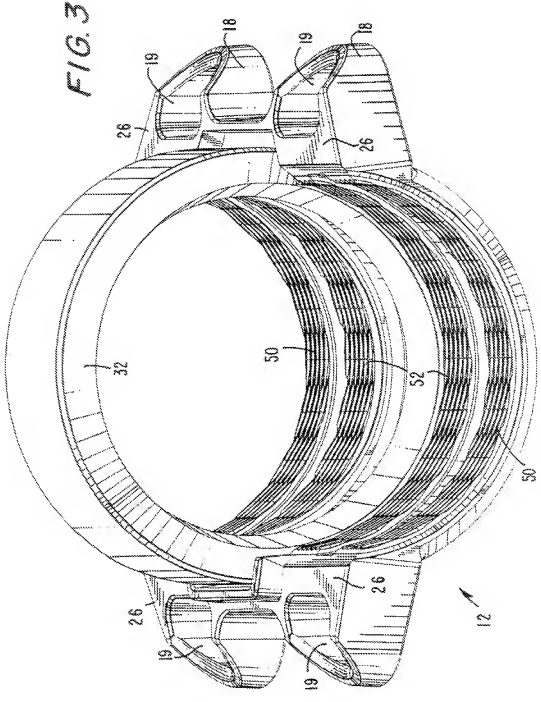


FIG. 4

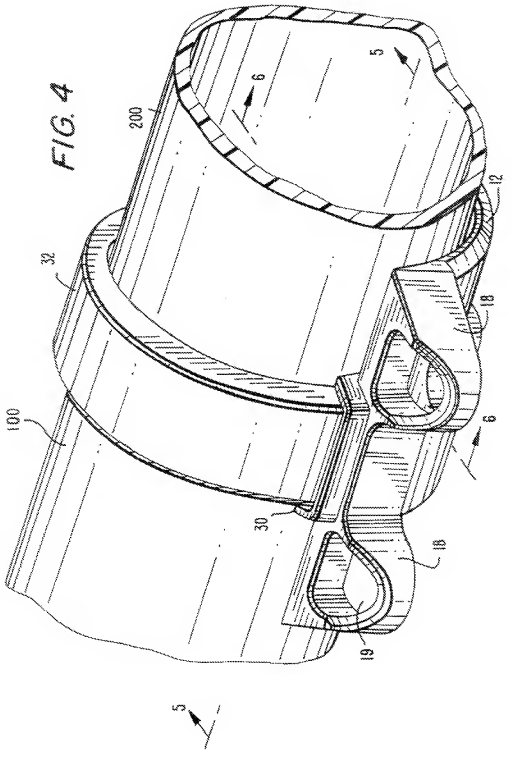
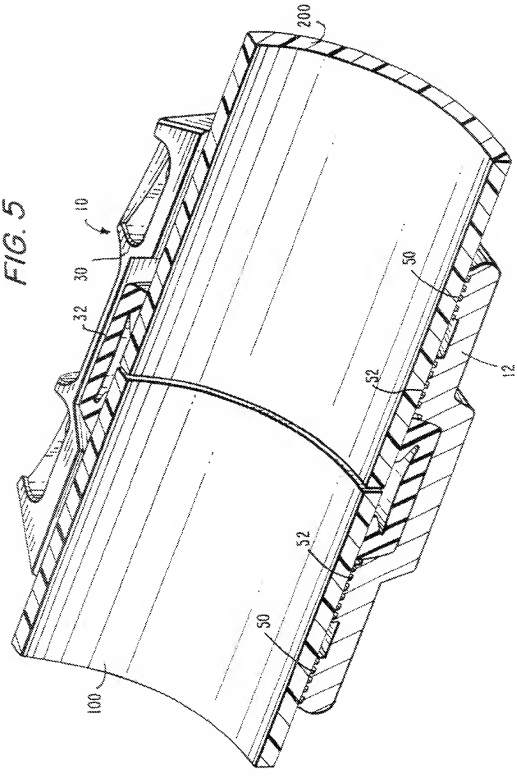


FIG. 5



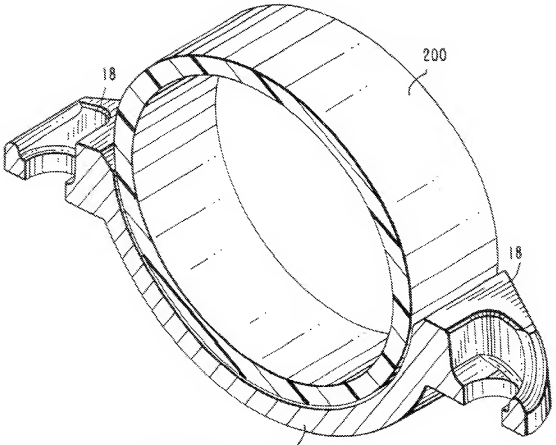
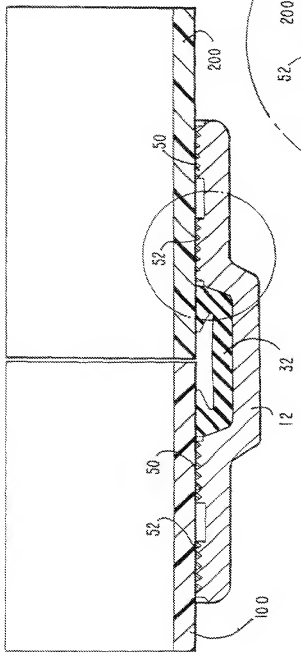


FIG. 6

FIG. 7



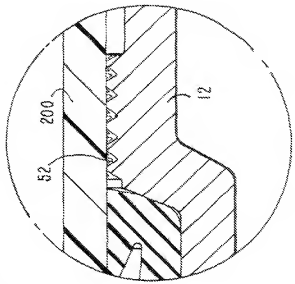


FIG.8

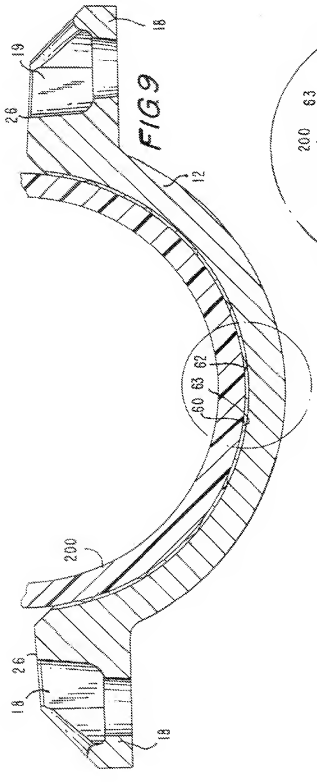


FIG 9

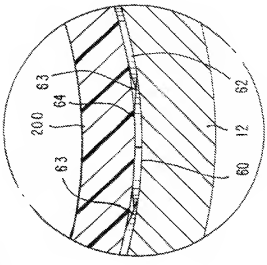


FIG. 10

COUPLING FOR PLAIN END PIPE

FIELD OF THE INVENTION

This invention relates to a coupling for plain ended pipe that is intended to securely engage the plain ended pipe without cutting into its pipe exterior. Such a coupling can be used to connect two plain ended pipes together, or one such pipe to another component such as a grooved or flanged component, or to another plain ended pipe constructed of a different material which requires coupling teeth that cut into its exterior surface.

BACKGROUND OF THE INVENTION

A variety of segmented pipe couplings are well known in the art, the respective coupling segments of such coupling being comprised of castings, typically of ductile iron, whose interior surface is configured to tightly engage the exterior circumference of the pipe as the coupling segments are typically bolted together in close mechanical engagement. One such type of coupling segment is shown in U.S. Pat. No. 4,611,495, assigned to the assignee of the present invention. It includes circumferentially extending keys at their respective opposite sides, which are shaped to be received within complementary grooves cut or otherwise formed in the exterior circumference of the pipe. The keys act to resist axial stresses that are generated on the pipes, with the axial stresses being absorbed by the coupling as a tensile or a compressive stress. A sealing gasket is also provided intermediate the sealing spaced keys.

The present invention is however directed to a segmented pipe coupling which is intended to be secured to a plain ended pipe. That is, a pipe that does not have a circumferential groove for the reception of a complementary key formed along the internal circumference of the coupling. Such plain ended pipe couplings must include some means along their inner circumferential area to tightly engage the exterior surface of the plain ended pipe, and maintain such secure engagement under varying temperature extremes and loads. One such coupling formed of a ductile iron casting intended for utilization in conjunction with high density polyethylene plain ended pipe are the commercially available Styles, 995, 995, and 997 couplings of the Victaulic Company of America, Easton, Pennsylvania. That coupling includes sharp circumferential teeth which engage, and actually cut into the pipe wall as the coupling bolts are tightened. A variation of this type of coupling segment includes separate sharp teeth formed in hardened steel cutter members inserted within the inner circumference of the coupling for cutting into the exterior surface of the pipe, as is disclosed in U.S. patent application Ser. No. 08/690,481 filed on Jul. 31, 1996 issued as U.S. Pat. No. 5,911,446 and assigned to the assignee of the present invention. Such sharp circumferential teeth that penetrate and bite into the exterior wall of the plain ended pipe are typically required where the coupling is formed of cast ductile iron and the pipe is formed of high density polyethylene. This is necessary for adequate holding strength under a wide temperature range. High density polyethylene has a substantially larger coefficient of thermal expansion than the iron forming the coupling. Thus it will shrink considerably in diameter and length when cooled and expands considerably in diameter and length when heated. Since the ductile iron which forms the coupling has a substantially smaller coefficient of expansion, the high density polyethylene pipe will outshrink the ductile iron coupling when cooled and outexpand the ductile iron coupling when heated. Hence it is necessary for the teeth to actually cut into the exterior wall of the high density polyethylene pipe in order to properly maintain a secure coupling engagement therebetween when the pipe coupling is cooled. This prevents coupling disengagement when the high density polyethylene pipe will shrink more in diameter relative to the ductile iron coupling upon such cooling. Further, the shrinking in pipe length puts a substantial axial load on the couple joint. To hold the joint together, it is required that the coupling stay sufficiently engaged on the reduced diameter of the high density polyethylene pipe, thereby necessitating the utilization of teeth which actually cut into the pipe exterior.

While such prior couplings have provided satisfactory performance in conjunction with plain ended high density polyethylene pipe, it creates certain disadvantages when used in a pipe coupling intended for polyvinylchloride pipe or other pipe materials (e.g., fiber reinforced plastic pipe) which have a lesser coefficient of thermal expansion than high density polyethylene pipe. The sharp circumferential teeth required for coupling to plain ended high density polyethylene pipe would create circumferential notches in the polyvinylchloride pipe. Such notches are detrimental to the pipe's long term performance, since such notches create potential crack initiation points. Similarly when used with fiber reinforced plastic pipe the teeth cut the fibers, which may typically be carbon, glass, or other reinforcing fibers.

U.S. Pat. No. 4,568,112 has recognized the desirability of providing a segmented coupling for polyvinylchloride pipe which avoids the piercing or breaking of the exterior surface of the polyvinylchloride pipe. That patent employs continuous circumferential ribs in alternating combination with a rough machine phonographic type finish. While not cutting into the pipe, such continuous circumferential depressions disadvantageously create sources of high stress concentration within the polyvinylchloride pipe. Further, the circumferential gripping ribs shown in U.S. Pat. No. 4,568,112 contain a 1° taper on the gripping zone of the flange adapter. This taper is in the direction that creates deeper pipe depressions at the back end or outboard end of the flange adapter. Since this is an area of highest stress in the pipe created by the flange adapter, it will be a point of highest stress in applications involving pipe bending and cyclic pressure. Since this is an area where pipe failure oftentimes is initiated, the flange adapter with its 1° taper exacerbates this potential for pipe failure. Another disadvantage of the coupling structure shown in U.S. Pat. No. 4,568,112 is that the two coupling segments do not meet pad to pad. This requires the installer to measure the torque being applied to the bolts as the segments are pulled together and into contact with the pipe surface to insure that they will be at an adequate magnitude to prevent the pipe from being pulled out of the flange, but not at too high a level to overstress the pipe or flange. Relying on the measurement of torque magnitude to achieve a specific bolt load tends to be imprecise due to the inherent imprecision of bolt load generation as well as anticipated variation generated by the installer. Thus it would be desirable to insure proper gripping force without resorting to bolt torque measurement.

SUMMARY OF THE INVENTION

The present invention provides a segmented pipe coupling in which each of the arcuate coupling segments include a successive series of circumferentially discontinuous teeth which extend radially inward along the inferior arcuate surface of the coupling segment. Each of the teeth includes an end section and a central radially inward substantially flat section. The flat sections of the successive series of teeth

provide a plurality of circumferentially discontinuous and space gripping surfaces which are adapted to engage and dent the plain ended pipe (typically polyvinylchloride) without cutting into the pipe exterior. Spaced dents are formed on the surface of the pipe by the teeth as the coupling is tightened. While not cutting into the pipe surface, the force required to displace the plastic away at the multiple spaced dents is substantial and provides a secure holding force.

It has been found particularly advantageous to form the spaced teeth by superimposed multi-lead right and left handed threads along the interior arcuate surface. Such threads can be formed by either (a) successively machining the right and left hand threads into an internal arcuate portion of the segmented pipe coupling, (b) casting the thread pattern into internal arcuate portion of the segmented pipe coupling, or (c) providing couplings with separate knurled inserts having the desired multi-lead right and left hand thread configurations.

The circumferentially discontinuous, or interrupted, thread configuration advantageously reduces the coupling assembly bolt torques so that it is significantly easier for the interrupted threads to deform the plastic pipe surface than with a 360° continuous circumferential ribs, as shown in aforementioned U.S. Pat. No. 4,568,112. With the discontinuous teeth of the present invention, the plastic of the pipe has paths of lesser resistance to move to than with circumferential ribs. More specifically, the discontinuous teeth of the present invention permit the plastic of the pipe to move radially inward and axially along the pipe and circumferentially between the teeth. Since the 360° ribs do not permit circumferential displacement, less load is required by the present invention to generate an equal depth grip with the exterior surface of the plastic pipe.

As a further advantageous feature of the present invention, each of the arcuate coupling segments include a flange at its arcuate end with a radially inward contact shoulder. The flange includes a bolt receiving aperture at its outward radial end for bolting the arcuate coupling segments together about the plain ended pipe. The contact shoulders of arcuately adjacent coupling segments are predeterminedly configured to meet as the adjacent coupling segments are bolted together, with such meeting in a pad-to-pad arrangement limiting their radially inward movement about the plain ended pipe. This establishes the termination of bolt tightening, without having to resort to the impreciseness of measuring the bolt load.

Accordingly, a primary object of the present invention is to provide a segmented pipe coupling for securement to plain ended pipe, which includes a successive or circumferentially discontinuous teeth which extend radially inward and are configured to securely engage the pipe without cutting into the pipe exterior.

A further object of the present invention is to provide such a segmented pipe coupling which is formed of cast ductile iron and intended to engage plain ended polyvinylchloride pipe.

A further object of the present invention is to provide such a segmented pipe coupling in which the individual teeth include a substantially flat pipe engaging portion, and the teeth are formed of superimposed multi-lead right and left handed threads along the interior arcuate surface of the coupling segment.

Yet another object of the present invention is to provide such a segmented pipe coupling in which successive circumferentially adjacent teeth are axially spaced.

Yet a further object of the present invention is to provide such a segmented pipe coupling in which the teeth include a plurality of individual circumferentially aligned and axially spaced teeth.

Still another object of the present invention is to provide a method of forming a plurality of circumferentially spaced and discontinuous thrust gripping teeth along the interior surface of a segmented pipe coupling intended for plain ended pipe, which includes the steps of forming a multi-lead right hand thread and multi-lead left hand thread superimposed over the right hand thread portion.

These as well as other objects will become apparent upon a review of the following drawings and detailed descriptions.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of one form of the present invention, showing a coupling intended for securing two plain ended pipes together, with the pipes not shown.

FIG. **2** is an interior plan view of one of the coupling segments.

FIG. **3** is a perspective view of one of the coupling segments with the intermediate sealing gasket.

FIG. **4** is a perspective view showing the segmented pipe coupling about the pipe, but prior to the bolting thereof.

FIG. **5** is a cross sectional view along the lines **5**—**5** shown in FIG. **4** and looking in the direction of the arrows.

FIG. **6** is a cross sectional perspective view along the line **6**—**6** shown in FIG. **4** and looking in the direction of the arrows.

FIG. **7** is a front cross-sectional view showing the lower portion of FIG. **5**.

FIG. **8** shows further details of a portion of FIG. **7**, as indicated by the circled portion thereof.

FIG. **9** is a front cross-section view showing the lower portion of FIG. **6**.

FIG. **10** shows further details of FIG. **9** as indicated by the circled portion thereof.

DETAILED DESCRIPTION

The segmented pipe coupling **10** shown in FIGS. **1**–**10** is intended to join the plain ends of two pipes, such as **100**, **200** (see FIGS. **4** and **5**), which may be formed of polyvinylchloride. Such coupling segments are typically formed of close tolerance casting techniques from ductile iron. The segmented pipe coupling of this embodiment includes two coupling segments **12**, **14**. The coupling segments are identical with each other and are substantially semi-circular in form, each coupling member half being comprised of an arcuate body **16** which terminates at its ends in radially outwardly extending bolting pads **18** formed integrally with the body portion **16**. While the particular segmented coupling **10** is comprised of only two coupling members, it will be well appreciated as is well known in the coupling art, that the segmented coupling could comprise three or more coupling segments which may be used in conjunction with larger diameter pipes. The use of multiple coupling segments facilitates the manual handling of the segments and the assembly of the coupling onto such larger diameter pipes. Additionally, the formation of such larger size segmented couplings from multiple coupling segments facilitates the forming of the respective coupling segments to closer tolerances that might otherwise be possible in the case of a large segmented coupling comprised of only two arcuate coupling segments.

Each of the radially extending bolt pads **18** includes apertures **19** for the reception of fastening members, which

may typically be headed bolts **22**. When in an assembled condition, the respective coupling segments **12**, **14** are secured to each other in end circling relationship about the ends of pipes **100**, **200** by the headed bolts **22** and conventional nuts or lock nuts **24** threadedly received on the bolts. Advantageously, each of the bolt pads **18** includes radially inward shoulder **26**. The shoulders of the arcuately adjacent coupling segments are pre-determinedly configured to meet as the arcuate coupling segments are bolted together, with the contact engagement of shoulders **26** limiting the radially inward movement of the arcuate segments **12**, **14** as the bolts are tightened. This pad-to-pad limiting engagement of the shoulder surfaces of adjacent segments advantageously assures the desired gripping engagement without the need to use bolt torquing as a guide.

Internally of each coupling segment **12**, **14** and intermediate the axial length thereof in the embodiment illustrated, is a recess **30** in which a lubricated gasket **32** is inserted. The gasket is employed to seal the pipes **100**, **200** when the coupling is in the assembled condition with the nuts **24** tightened.

In accordance with the present invention, an array of a successive series of circumferentially discontinuous teeth extend radially inward along the interior arcuate surface of each of the coupling segments, with two such areas of teeth **50**, **52** being illustratively in each of the coupling segments. It should, however, be understood that alternatively a single area of such teeth may be provided in an area which substantially expands the entire width between the axial end extremes of areas **50**, **52**. These teeth are provided to securely engage the exterior surfaces of the polyvinylchloride pipe, as best shown in FIGS. **5** and **7** through **10**. It is most important in accordance with the present invention that the teeth be configured such that they engage the exterior surfaces of the pipe **100**, **200**, without cutting into the pipe exterior. This is to be contrasted to the gripping pattern of teeth in the coupling members typically used for high density polyethylene pipe which are intended to puncture and bite into the exterior surface of the pipe in order to maintain secure engagement therewith under conditions of ambient temperature extremes. Such coupling segments which have provided satisfactory performance for coupling plain ended high density polyethylene pipe are typified by Styles 994, 995, and 997 of the Victaulic Company of America.

The individual gripping teeth in areas **50**, **52** are circumferentially discontinuous. Referring to FIGS. **9** and **10**, successive circumferentially adjacent teeth, such as **60**, **62** include a central radially innermost flat section **64** and inclined end sections **63**. As shown in FIG. **3**, the teeth, in alternate circumferential rows, will be in circumferential alignment and the teeth in adjacent rows, such as **70**, **71**, will be circumferentially spaced. Further, such circumferentially adjacent teeth **70**, **71** may also be considered to be axially spaced by virtue of their location in adjacent rows.

Thus, it should be appreciated that the individual teeth provided within areas **50**, **52** provide a successive series of circumferentially discontinuous teeth extending radially inward along the interior arcuate surface of the coupling segment. By virtue of their substantially flat, blunt ends, in conjunction with the controlled tightening of the coupling segments which is limited by the engagement of shoulders **26** of the flange ends, the teeth will provide a plurality of spaced engaged surfaces with the exterior of the pipe to securely hold the pipe, without puncturing the pipe surface. The utilization of individual spaced teeth, rather than an uninterrupted circumferential rib, achieves several advantages. The spaced teeth permit the plastic of the pipe to move radially inwardly, axially along the pipe and circumferentially. This reduces the load required to provide the requisite depth grip. Further, circumferential depressions provide sources of higher stress concentration than would be present in the spaced teeth of the present invention. This is particularly important in cyclic pressure and/or bending applications, since cyclic pressure repeatedly strains the pipe, the areas of highest stress provide weakened areas and locations with a tendency to initiate pipe failure. Accordingly, the spaced teeth of the present invention, as compared to circumferential depressions, provide reduced stress to the pipe.

A particularly advantageous method of configuring the gripping teeth is to form the teeth of superimposed multi-lead right and left handed threads along its interior arcuate surface. One such method is to successively machine multi-lead right and left hand threads into the previously cast internal arcuate portion of the segmented pipe coupling. Alternatively, the final configuration of spaced gripping teeth can be cast into the coupling.

Accordingly, it should be appreciated that the present invention is directed to a coupling component which includes a successive series of circumferentially discontinuous teeth that extend radially inward along the interior arcuate surface of the coupling segment and are configured to securely grip a plain ended pipe without cutting into the pipe exterior. It has been found that such a coupling component has particular utility in conjunction with cast ductile iron couplings intended for use with polyvinylchloride pipe, since the differential coefficients of expansion between the iron and the polyvinylchloride is not of a magnitude which necessitates coupling teeth to bite into the pipe in order to maintain secure engagement therewith over temperature extremes. Further, while the present invention has been disclosed in conjunction with a coupling member intended to join the plain ends of two pipes, the advantageous discontinuous teeth configuration can be used in conjunction with other types of coupling members intended to secure a plain ended plastic pipe to some other component. Accordingly, these as well as other modifications will suggest themselves to those familiar with pipe couplings which are considered to be within the spirit and scope of the invention as defined by the following claims:

We claim:

1 A segmented coupling device for coupling two pipe elements selected from the group consisting of two plain-ended sections of pipe; and one plain ended section of pipe and a pipe fitting, the segmented coupling comprising a plurality of arcuate coupling segments, each of the arcuate coupling segments including:

a successive series of circumferentially discontinuous teeth extending radially inward along the interior arcuate surface of the coupling segment;

each of the teeth including end sections and a central, radially innermost flat section;

the flat sections of the successive series of teeth providing a plurality of circumferentially discontinuous and spaced gripping surfaces for securely engaging at least one plain ended pipe section without cutting into the pipe exterior;

and each arcuate coupling segment having means for being detachably attached to at least one other adjacent arcuate coupling segment in surrounding relationship around an outer circumference of the abutting ends of the two pipe elements to be coupled.

2. An arcuate coupling segment according to claim 1, wherein, successive circumferentially adjacent teeth are axially spaced.

3. An arcuate coupling segment according to claim 1, wherein the teeth include a plurality of individual circumferentially aligned and axially spaced teeth.

4. An arcuate coupling segment according to claim 1, wherein, the teeth include a plurality of individual circumferentially aligned and axially spaced teeth, and successive circumferentially adjacent teeth are axially spaced.

5. An arcuate coupling segment according to claim 1, wherein, the teeth are formed within an axially serrated plurality of circumferential rows, each of the rows including a successive series of spaced individual teeth, and the flat surfaces of adjacent teeth within a circumferential row being separated by an end section forming a junction and spacing between the adjacent teeth within a circumferential row.

6. The arcuate coupling segment according to claim 5, wherein the teeth in spaced alternate circumferential rows are in circumferential alignment.

7. The arcuate coupling segment according to claim 6, wherein the teeth in adjacent rows are circumferentially spaced.

8. The arcuate coupling segment according to claim 7, wherein the teeth are formed of superimposed multi-lead right and left handed threads along an interior arcuate surface of the segment.

9. The arcuate coupling segment according to claim 5, wherein the teeth in adjacent rows are circumferentially spaced.

10. The arcuate coupling segment according to claim 5, wherein the teeth are formed of superimposed multi-lead right and left handed threads along an interior arcuate surface of the segment.

11. An arcuate coupling segment according to claim 1, wherein the teeth are formed of superimposed multi-lead right and left handed threads along an interior arcuate surface of the segment.

12. An arcuate coupling segment according to claim 1, which is formed of iron and is intended for use with plain-ended PVC pipe.

13. A segmented pipe coupling comprising a plurality of arcuate coupling segments, each of the arcuate coupling segments including:

a successive series of circumferentially discontinuous teeth extending radially inward along an interior arcuate surface of the coupling segment;

each of the teeth including radially inclined end sections and a central, radially innermost, flat section;

the flat sections of the successive series of teeth providing a plurality of circumferentially discontinuous and spaced gripping surfaces for securely engaging a plain ended pipe without cutting into the pipe exterior;

each of the arcuate coupling segments including at least one flange at its arcuate end, the flange including a fastener receiving aperture at its outward radial end for detachably attaching adjacent arcuate coupling segments together around the outer circumference of the ends of abutting pipe segments selected from the group consisting of the two plain-ended pipes; and one plain-ended pipe and a pipe fitting, and a radially inward shoulder, such that the shoulders of arcuately adjacent coupling segments are predeterminedly configured to

meet as the adjacent arcuate coupling segments are fastened together in order to limit radially inward movement of the fastened coupling segments about the coupled ends of the pipe segments.

14. A segmented pipe coupling for attachment to a first pipe section and a PVC pipe section, the pipe coupling including:

a successive series of circumferentially discontinuous teeth extending radially inward along an interior arcuate surface of the coupling segment,

each of the teeth including end sections and a central, radially innermost, flat section;

the flat sections of the successive series of teeth providing a plurality of circumferentially discontinuous and spaced gripping surfaces for securely engaging the PVC pipe section without cutting into the pipe exterior; and means for detachably attaching the coupling around an outer circumference of abutting ends of the two pipe sections to be coupled.

15. The segmented pipe coupling according to claim 14, wherein the first pipe section is made from a material selected from the group consisting of metal and plastic.

16. The segmented pipe coupling according to claim 15, wherein the material is plastic.

17. The segmented pipe coupling according to claim 15, wherein the material is metal

18. The segmented pipe coupling according to claim 17, wherein the metal is iron.

19. The segmented pipe coupling according to claim 17, wherein the plastic is PVC.

20. A segmented pipe coupling comprising a plurality of arcuate coupling segments, each of the arcuate coupling segments including:

a successive series of circumferentially discontinuous teeth extending radially inward along the interior arcuate surface of each coupling segment;

each of the teeth including a substantially flat gripping surface;

the substantially flat gripping surfaces of the successive series of teeth providing a plurality of spaced gripping surfaces for securely engaging a plain ended pipe without cutting into the pipe exterior.

21. The segmented pipe coupling according to claim 20, wherein the teeth are formed of superimposed multi-lead right and left handed threads along an interior arcuate surface of the coupling.

22. The segmented pipe coupling according to claim 20 wherein:

each of the arcuate coupling segments includes at least one flange at an arcuate end, the flange further including a fastener receiving aperture at an outward radial end thereof for detachably attaching adjacent arcuate coupling segments together around the outer circumference of the ends of the abutting plain ended pipes, and a radially inward shoulder, such that the shoulders of arcuately adjacent coupling segments are predeterminedly configured to mat as the adjacent coupling segments are fastened together in order to limit radially inward movement of the fastened coupling segments about the coupled ends of the plain ended pipes.

* * * * *

Reference 3

United States Patent [19]

Larsen et al.

[11] 4,230,157

[45] Oct. 28, 1980

[54] **PIPE HAVING AN END PORTION, THE INNER WALL OF WHICH IS PROVIDED WITH A CIRCUMFERENTIAL GROOVE, IN WHICH A SEALING MEANS IS MOUNTED AND A PIPE JOINT CONSISTING OF THIS PIPE AND A SPIGOT END OF A SECOND PIPE INSERTED THEREIN**

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[73] Assignee: **Wavin B.V., Zwolle, Netherlands**

[21] Appl. No.: **8,035**

[22] Filed: **Jan. 31, 1979**

[30] **Foreign Application Priority Data**

Feb. 3, 1978	[DK]	Denmark	502/78
Feb. 3, 1978	[DK]	Denmark	503/78
Feb. 16, 1978	[DK]	Denmark	705/78
Jun. 12, 1978	[DK]	Denmark	2619/78
Jul. 14, 1978	[DK]	Denmark	3173/78
Jan. 26, 1979	[DK]	Denmark	347/79

[51] **Int. Cl.**³ **F16L 9/22**; F16J 15/32; F16L 19/00

[52] **U.S. Cl.** ..... **138/155**; 138/107; 277/207 A; 285/336, 285/345; 285/344

[58] **Field of Search** ..... 138/109, 178, 155; 277/207 A; 285/335, 336, 344, 345

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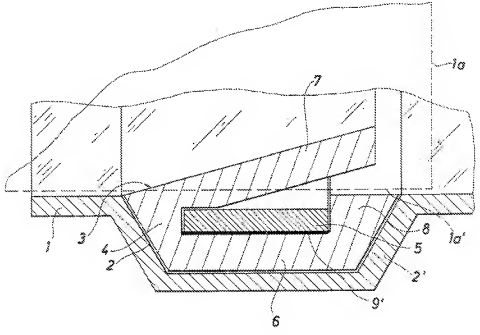
Primary Examiner—Richard E. Aegerter
Assistant Examiner—James E. Bryant, III
Attorney, Agent, or Firm—Wilkinson, Mawhinney & Theibault

[57] **ABSTRACT**

A pipe having a sealing member (3) in an inner groove (2) at one pipe end (1). The sealing member provides a very effective seal relative to a spigot end (1a) of another pipe inserted in the pipe in question. The free ends of lip portions (6,7) of a sealing ring (4) (the cross section of which is of V-shape when undeformed) are provided with heads (8) so that behind a stiffening ring (5) surrounding said sealing ring (4) there is more volume of lip material than there is room for in the space confined by the adjacent part of the bottom of the groove (2), the exterior (1a') of said spigot end (1a), the rearmost sidewall (2') of the groove (2) and the stiffening ring (5). The pipe is preferably a plastic pipe.

19 Claims, 17 Drawing Figures



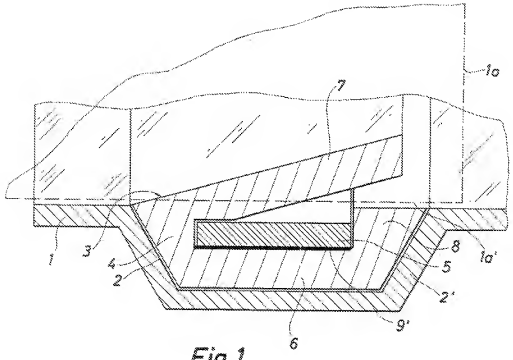


Fig. 1

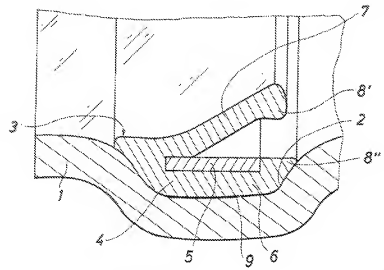


Fig. 2

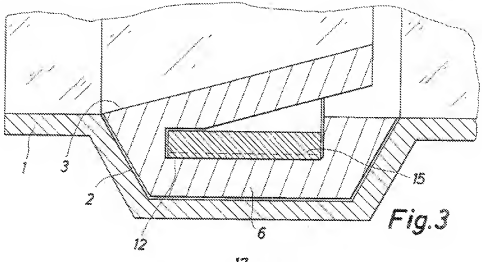


Fig.3

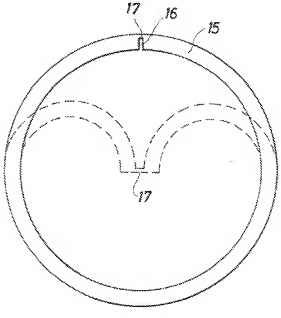


Fig.4

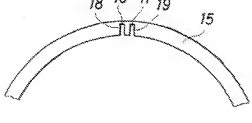


Fig. 5

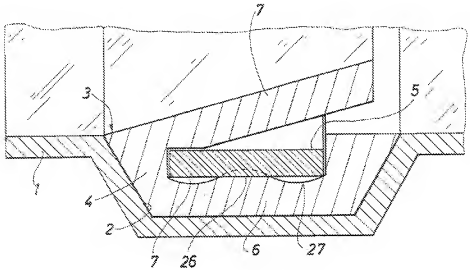


Fig.6

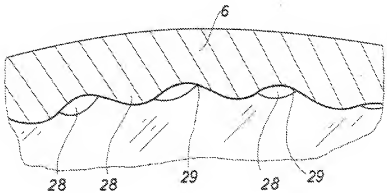


Fig.7

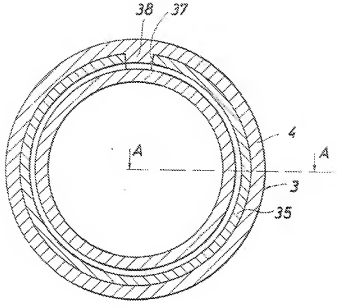


Fig. 8

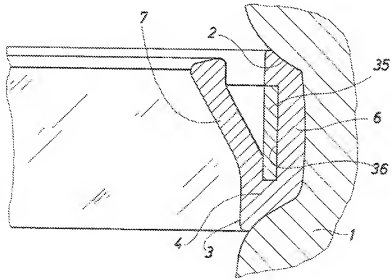


Fig. 9

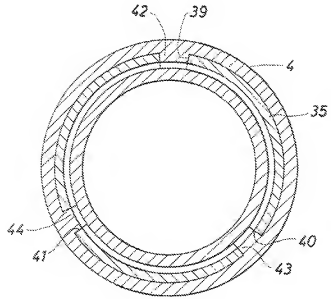


Fig. 10

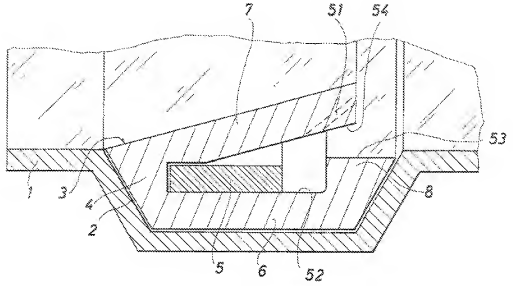


Fig. 11

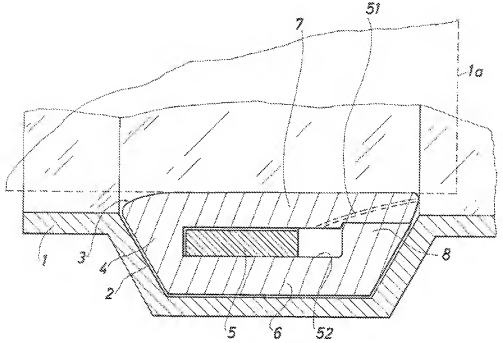


Fig. 12

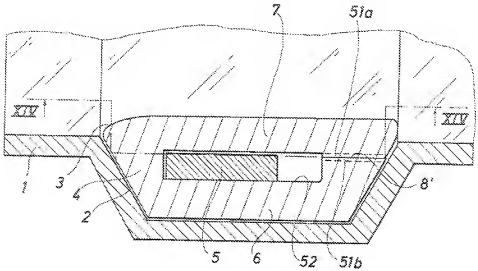


Fig. 13

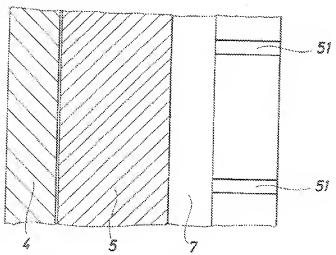


Fig. 14

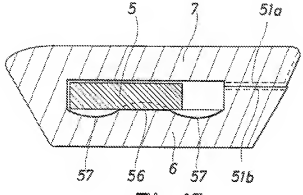


Fig. 15

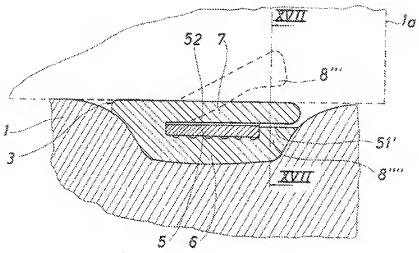


Fig. 16

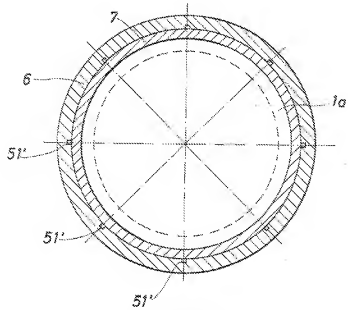


Fig. 17

PIPE HAVING AN END PORTION, THE INNER WALL OF WHICH IS PROVIDED WITH A CIRCUMFERENTIAL GROOVE, IN WHICH A SEALING MEANS IS MOUNTED AND A PIPE JOINT CONSISTING OF THIS PIPE AND A SPIGOT END OF A SECOND PIPE INSERTED THEREIN

The present invention relates to a pipe having an end portion, the inner wall of which is provided with a circumferential groove, in which a sealing means is mounted, said sealing means comprising a sealing ring, preferably of rubber, having a substantial V-shaped cross-section when undeformed consisting of at least two lip portions, and a stiffening body in cooperation with the sealing ring for holding one of the lips in the groove.

A pipe is known having a socket at one end, said socket being provided with an inner sealing means in the form of a sealing ring, inside of which two stiffening rings are mounted. The sealing means is not, however, mounted in a groove in the socket. The sealing ring has a substantially V-shaped cross-section. The free end of one V-lip is somewhat thick, whereas the free end of the second V-lip is rather narrow. Measured in axial direction the socket is approximately 1½ times longer than the sealing means. When the spigot end of a second pipe has been inserted into the socket, there is quite a lot of room between the outer surface of the spigot end and the inner surface of the socket to allow axial displacement of part of the sealing ring material further into the socket. For this reason there is no great degree of compression in the sealing ring behind the stiffening rings when viewed in axial direction from the end of the socket and consequently a rather insufficient seal between the socket and the spigot end is provided.

The object of the invention is to provide a pipe of the above type, which permits an especially effective seal between one end of the pipe and the spigot end of a second pipe inserted therein.

The pipe according to the invention is characterized in that the lengths of the lip portions of said sealing ring are such that both lip portions, when seen from the mouth of the pipe end portion, extend farther into the pipe than said stiffening body, and in that the dimensions of said lip portions are such that there is more volume of lip material behind said stiffening body, when viewed from the mouth of the pipe end portion, than there is room for in the space confined by the adjacent part of the bottom of the groove, the exterior of the spigot end of the second pipe to be inserted into the pipe end portion, the remotest sidewall of the groove and the stiffening body, so that the lip material in a state of compression and deformation substantially fills up said space. Thus a substantial compression but also a little displacement of the sealing ring material behind the stiffening body is established, and consequently an especially good seal between the two pipes is provided.

According to the invention one or both of the lip portions of the sealing ring may have a circumferential bead or ridge along its outer edges, i.e. substantially behind said stiffening body, when viewed from the mouth of the pipe end. As a result particularly good opportunities for the desired compression of lip material behind the stiffening ring are obtained.

Furthermore according to the invention a lubricant may be provided between the sealing ring and the bottom of the groove. By this means the sealing ring material, which is displaced behind the stiffening body, when viewed from the mouth of the pipe end, may rather easily be distributed under the stiffening body, thereby ensuring a more effective seal.

Moreover according to the invention a lubricant may be provided between the sealing ring and the stiffening body, also ensuring to a great degree better distribution of the sealing ring material under the stiffening body.

According to the invention the stiffening body surrounded by the lip portions may be a stiffening ring having one or more axial recesses, such as notches, extending radially and inwardly, and being formed so that the parts of said stiffening ring around said recess or recesses may be pressed inwardly so that the stiffening ring may be deformed to a kidney-like shape. By this means the stiffening ring and consequently the entire sealing means consisting of sealing ring and stiffening ring may more easily be mounted in the pipe groove in question, as the stiffening ring—possibly together with the sealing ring—is deformed during insertion into a kidney-like shape, thus taking up less room. They may be inserted axially into position in the groove without hindrance. The stiffening ring is then left alone, so that it presses the sealing ring outwardly with slight pressure. In principle the sealing ring and the stiffening ring may be mounted separately.

According to the invention the stiffening ring may have a substantially rectangular cross-section.

If the stiffening ring has two recesses, they may according to the invention be arranged in close proximity of each other, thus facilitating the manufacture, as the stiffening ring is easily made by injection molding in plastic, such as polypropylene. The rather weak joint line seam resulting from the injection molding is formed in the part of the stiffening ring situated between the recesses and not in the part of the ring at the bottom of the respective recesses which is already weak.

Furthermore according to the invention at least one side surface of the sealing ring lip portion located between the stiffening ring and the bottom of the groove may have protuberances and depressions, which are compressed and made smaller respectively in the radial direction of the pipe when both the sealing ring and the stiffening ring have been secured in their places in said groove and the lip portions of said sealing ring have at the same time been deformed by the inserted pipe end. A very effective sealing is thus provided, permitting the sealing means at the same time to compensate for the differences of dimension that may occur within the diametrical range, in which the individual sealing means is to be used. It is then possible for the material in the protuberances in the lip portion in question to be displaced by the bottom wall surface of the groove and by the stiffening ring towards the adjacent depressions and to be received into said depressions.

According to the invention the protuberances and the depressions may be situated on the side surface of said lip portion abutting said stiffening ring.

Moreover according to the invention the protuberances may be bumps, which together with corresponding depressions are evenly distributed over one or more side surfaces of the lip portion in question, whereby it is possible for the sealing ring to fit many different types of stiffening rings.

According to the invention the protuberances and depressions may furthermore consist of one or more continuous circumferential bulges and corresponding

circumferential depressions, whereby an even distribution of biasing forces in the sealing ring is achieved, making the seal especially effective.

According to the invention the stiffening ring completely or partially surrounded by the lip portions may furthermore have at least one through aperture completely interrupting the peripheral continuity of the stiffening ring, and the outer lip portion of the sealing ring may have an inwardly extending projection corresponding to each aperture in said stiffening ring, said projection being received into the respective aperture in said stiffening ring. This permits the sealing means to be easily inserted into position in the groove of the pipe end portion, as a part of the sealing ring outside the aperture in the stiffening ring may be deformed radially and inwardly during the insertion, optionally by manual impression. The above-mentioned part is not released until the sealing ring and the stiffening ring are situated radially outside the groove of the pipe end portion. Because of the aperture or apertures the stiffening ring is relatively easily manufactured by, for example, cutting suitable lengths from a strip material. The inwardly extending projection received into the apertures in the stiffening ring allows for compensation of differences of dimension and for the taking up of the spreading parts of the sealing ring material when the latter is pressed against the bottom of the groove in the pipe end portion. The aperture or apertures in the stiffening ring ensure at the same time that the sealing ring is not permanently deformed, although the sealing ring is deformed as mentioned during insertion into its position in the groove. When the draftsman gives the inwardly extending projections a certain size, the sealing ring may provide a certain pre-compression in the stiffening ring. At the same time the stiffening ring may press the sealing ring tightly against the bottom of the groove.

Also the stiffening ring may according to the invention be mounted in a circumferential auxiliary groove in the outer or inner lip portion, said auxiliarly groove only being interrupted by the projection or projections extending radially inwardly from the outer lip portion. By this means continuity between the separate parts of the sealing means is ensured.

An embodiment of the pipe that is particularly suitable as a pressure pipe is according to the invention characteristic in that the sealing ring, in which the stiffening ring is mounted, is formed so that at least in compressed state, when the spigot end of a second pipe has been inserted therethrough, said sealing ring shows an inner circumferential cavity, and in that the end of the sealing ring farthest from the mouth of the pipe end portion is provided with at least one access channel situated so that it brings the interior of the pipe in communication with said circumferential cavity. By this means an especially effective seal is achieved between the outer portion of the sealing ring and the bottom of the groove, as the (often great) pressure inside the pipe will always be able to move to the circumerential cavity and thus to the inner side of the outer lip portion, so that the latter is pressed hard (with great strength) against the bottom of the groove. It has been possible to prove the good sealing effect during experiments in a special sand box, in which a pipe joint consisting of the pipe according to the invention and the spigot end of a second pipe inserted therein was buried, and in which the pressure of the sand on the pipe joint was adjustable to various values.

It is especially advantageous if the access channel or channels are formed at the free end of one or both of the lip portions of the sealing ring.

Also according to the invention the access channel or channels may advantageously be formed in a bead or ridge on the free end of one, preferably the inner, lip portion, or of both portions.

Furthermore according to the invention the access channel or channels may be formed in the end contact surfaces of the lip portions, which are compressed against each other. By this means the manufacture of the channels is made simple, since said channels may for example be small grooves in the end contact surfaces.

It is most advantageous according to the invention if the channels are evenly distributed around the surface of the sealing ring, when viewed in peripheral direction.

The invention also relates to a pipe joint consisting of the pipe described above and the spigot end of a second pipe inserted therein.

In a pipe assembling according to the invention the sealing means may have portions providing a compression sealing (a seal as a result of the pressure from a pressurized fluid in the pipe that has moved into the circumferential cavity of the sealing ring) and portions providing a lip seal (a seal as a result of compression of the lip material because of excess of such material). When functioning correctly there is a back-up measure if one of the portions fails.

The invention will be described below with reference to the drawings, in which

FIG. 1 is part of an axial sectional view of a pipe according to the invention extending from the mouth of the pipe end portion, and in which a lubricant has been applied between the outer lip portion of the sealing ring and the stiffening ring,

FIG. 2 is part of an axial sectional view of another embodiment of the pipe according to the invention (extending from the mouth of the pipe end portion), in which a lubricant has been applied between the outer lip portion of the sealing ring and the bottom of the groove,

FIG. 3 is an axial sectional view of the end of a pipe, in which a sealing means with a stiffening ring that may be bent temporarily into a kidney-like shape has been mounted,

FIG. 4 is a stiffening ring corresponding to the one used in FIG. 3, viewed from the front in undeformed (i.e. circular) and deformed (i.e. kidney-shaped) state,

FIG. 5 is part of another embodiment of the stiffening ring,

FIG. 6 is an axial sectional view of a pipe end portion, in which a sealing means with a sealing ring that has protuberances and depressions on a surface, has been mounted,

FIG. 7 is a radial sectional view of a part of another embodiment of the sealing ring,

FIG. 8 is a radial sectional view of a sealing means according to the invention, which is easily deformed during insertion into a groove in the pipe end portion, as the stiffening ring has only one through aperture,

FIG. 9 is on a larger scale an axial sectional view taken along the line A—A in FIG. 1, said section showing the sealing means mounted in the groove in the pipe end portion, the latter being only shown in part,

FIG. 10 is another embodiment of a sealing means, in which the stiffening ring has three through apertures.

FIG. 11 is part of an axial sectional view of a pipe according to the invention extending from the mouth of the pipe end portion, as the sealing ring is shown un-

deformed, and the inner lip portion of the sealing ring is provided with an access channel at its rearmost end, said pipe being especially suited as a pressure pipe,

FIG. 12 is the same as FIG. 11; however, the sealing means is deformed,

FIG. 13 is another embodiment of the pipe, in which the access channels of the sealing means are located at the end contact surfaces of the lip portions, which are compressed against each other,

FIG. 14 is a sectional view taken along line XIV—XIV in FIG. 13, showing part of the inner lip portion, whereby two access channels are seen on a ridge at the rear end of the lip portion,

FIG. 15 is a sealing ring, in which the access channels are formed in a ridge on the outer as well as the inner lip portion, and in which protuberances and depressions are provided on the surface of the outer lip portion facing the stiffening ring,

FIG. 16 is an axial sectional view of part of a pipe according to the invention, in which the sealing ring may provide two kinds of seal, and

FIG. 17 is the same as FIG. 16, taken along line XVII—XVII in FIG. 16, from which it is clearly seen how the access channels are distributed around the surface of the sealing ring.

The pipe shown in FIG. 1 has an end portion 1, the inner wall of which is provided with a circumferential groove 2. A sealing means (undeformed in the drawing) having the general reference number 3 is mounted in the groove and comprises a sealing ring 4, preferably of rubber, and a stiffening body 5, for instance a stiffening ring, in cooperation with the sealing ring. The stiffening body is adapted to press the sealing ring 4 against the bottom of the groove 2 to prevent the sealing means from being forced out of the groove when the spigot end 1a of a second pipe is inserted into the pipe end portion 1.

The sealing ring 3 is substantially V-shaped in cross-section and consists of two circumferential lip portions 6 and 7, of which the outer lip portion 6 is adapted to abut the bottom of the groove 2, whereas the inner lip portion 7 extends diagonally and inwardly from the front end of the sealing means as shown. The stiffening body 5, which has a rectangular cross-section in the embodiment of the invention shown in the drawing, is mounted in an auxiliary groove 6a in the outer lip portion 6.

As shown the lengths of both lip portions 6 and 7 are such that the lip portions extend farther into the pipe than does the rearmost end of the stiffening body 5 when viewed from the pipe end. The lip portion 6 is furthermore provided with a circumferential bead or ridge 8 along its free edge behind the stiffening body 5. The dimensions of the ridge or bead 8 are such that when the second pipe 1a' has been inserted, there is more volume of material between the outer wall 1a'of the second pipe and the bottom of the depression 2 than there is room for, and for this reason the sealing ring material must be displaced behind the stiffening body as well. This space, which becomes completely filled up with lip material, extends axially from the rear wall 2' of the groove 2 to the stiffening body 5, whereas the space extends radially from the bottom of the groove 2 to the outer surface 1a' of the spigot end 1a.

The lip material is primarily compressed in the above-mentioned space, but is also displaced a little as mentioned above.

Both lip portions 6 and 7 may optionally have a circumferential bead or ridge along their free edge behind the stiffening body 5. Such beads 8' and 8'' on the lip portion are particularly clearly shown on the lip portions in FIG. 2. Furthermore the pipe shown in FIG. 2 corresponds essentially to the one shown in FIG. 1.

A suitable lubricant 9 is provided between the sealing ring 3 and the bottom of the depression 1, said lubricant ensuring that the lip material may more easily be displaced and distributed under the stiffening body 5 towards the mouth of the pipe end portion. The lubricant may, however, be applied between the stiffening body 5 and the outer lip portion 6, as shown by 9' in FIG. 1. The lubricant may be of many different types, such as talcum powder, graphite, molybdenum sulphide. Other lubricants may be used, such as wax with low surface friction, such as polyfluorinated waxes and polyethylene wax. The same is true of lubricants such as silicone grease and cup grease as well as only substances such as silicone oil.

The pipe shown in FIG. 3 corresponds to the pipes mentioned above; however, the stiffening body 15, a ring, which is mounted in an auxiliary groove 12 in the outer lip portion 6, is formed in a special way.

First of all the stiffening ring 15 is a very sturdy type and has a substantially rectangular cross-section, but besides this it has an axial recess in the form of a recess, such as a notch 6, whose width and depth is such that when mounting the entire sealing means, the stiffening ring may be (manually) deformed and given the kidney-like contour indicated by the dotted lines in FIG. 4. Consequently the thin part 17 of the ring situated at the bottom of the notch functions as a hinge.

The other embodiment of the stiffening ring shown in FIG. 5 is provided with two axial notches 18 and 19, the ring thus having two thin-walled parts 10 and 11, which together function as a hinge when the stiffening ring is mounted.

The stiffening ring may be made of any suitable material, such as metal or plastic. It may, for example, be injection molded out of polypropylene, which is suitable for forming hinge-like parts capable of withstanding many mountings and dismountings.

The stiffening ring may also have another cross-section than a rectangular one, just as the recess or recesses may have another shape than the one shown, provided that the wall thickness of the material at the bottom of the recesses is so little that said material may function as a hinge during the above-mentioned deformation of the stiffening ring.

A pipe is shown in FIG. 6, in which the inner surface of the lip portion 6 of the sealing means 4 has a circumferential bulge or protuberance 26 between two circumferential depressions 27. Before the stiffening ring is mounted the protuberance 26 has the contour indicated by the dotted lines, whereas after the stiffening ring has been mounted the protuberance shown in FIG. 6 has a flatter, more compressed contour, since the material in the protuberance 26 in this case is displaced into the adjacent depressions 27. Consequently the lip portion 6 becomes tightly fixed between the bottom of the groove 2 and the stiffening ring 5.

Instead of a circumferential protuberance the underside of the lip portion 6 may be provided with protuberances in the form of evenly distributed bumps 28, between which there are depressions 29, into which the material in the bumps may be forced when the sealing

means is mounted in its position in the inner groove 2 in the pipe end portion 1.

Instead of a single circumferential ridge 26, the lip portion 6 may have several circumferential ridges surrounded by circumferential depressions, just as the lip portion 6 in certain cases may be provided with axially extending ridges (not shown) evenly distributed around the entire surface. Furthermore the protuberances and depressions mentioned above may also be formed on the side of the lip portion 6 abutting the groove 2.

The pipe in FIG. 8 and 9 corresponds to the pipes mentioned above; however, in the present embodiment the stiffening ring 5 and the sealing ring 4 are formed such that the sealing means 4 may be easily deformed when said sealing means is to be positioned in the groove 2. The stiffening ring 5 is situated in the auxiliary groove 6a and has a through aperture 37 completely interrupting the peripheral continuity of the annular body in one spot. A projection 38 on the sealing ring (i.e. on the outer lip portion 6) extends radially and inwardly through said aperture 37 and fills it completely up.

The shape of the sealing ring and the stiffening ring shown in FIG. 10 is characteristic in that it has three through apertures 39, 40 and 41, each of which is filled up by the inwardly extending projection 42, 43 and 44 on the sealing ring 4.

The stiffening ring may in this case be made of many different types of material, for example metal or plastic. It may possibly be made by cutting a strip of plastic.

It should be noted that the lip portions 6 and 7 of the sealing ring completely or partially surround the stiffening ring. The projections and the apertures in the stiffening body corresponding to the projections may have other types of cross-sections than the ones shown.

The pipe illustrated in FIGS. 11 and 12 corresponds to the ones described above, but the sealing ring 4 is specially formed. As shown the inner lip portion has at least one access channel 51, which will also be open when the spigot end 1a has been inserted in the pipe end portion 1, so that the pressure medium flowing through the pipe end portion 1 may freely flow into one of the circumferential cavities 52 formed by the lip portions 6 and 7. Consequently the pressure may be equalized, so that the lip portion 6 is pressed outwards with great strength, tightly abutting the bottom of the groove 2. If both lip portions or only one has a ridge at its rearmost end, i.e. behind the stiffening ring, the ridge or ridges may be broken through by said channels. When the channels are being put into position, they must not be blocked by the spigot end 1a of the inserted pipe. In FIG. 11 the sealing ring is undeformed; in FIG. 12 it is compressed

As shown in FIG. 13 the channels may be formed in the end contact surfaces 53 and 54 of the lip portions 6 and 7, which are compressed against each other. They are made up of small grooves 51a and 51b, which may possibly be opposite each other.

In FIG. 14 part of the lip portion 7 is shown, and the way in which the little groove 11a is placed on the ridge 8' of the lip portion.

In FIG. 15 it is clearly visible that if the side of the lip portion 6 facing the stiffening ring 5 is provided with protuberances 56 and depressions 57, the access channels 11a' must be placed so as to always be adjacent to the depressions 57. If they are placed in the vicinity of the protuberances 56, they may be blocked during the compression of the sealing ring, when the spigot end of the second pipe is inserted in the sealing means.

A lubricant may be applied to the side surface of the lip portion 6 facing the sealing ring 5, so that the material of the lip portion 6 may more easily be distributed around the stiffening ring, when the pipe joint is established.

The circumferential cavity 52 may in certain cases be very little, namely when there is only a little clearance between the stiffening ring and the lip portions 6 and 7, cf. FIG. 13.

The sealing ring in the sealing means shown in FIG. 16 may provide a seal in two different ways, which support each other, i.e. by compression sealing, by the pressurized fluid in the circumferential cavity 52 of the sealing ring pressing the lip portion 7 outwards, and by the lip sealing, by compression of the lip material behind the stiffening ring 5 (seen from the mouth of the pipe end portion 1'), because there is more lip material here than there is room for, cf. that the lip portion 7 has a ridge 8"', which is pressed radially outwards towards the ridge 8"", when the spigot end 1a of a second pipe is inserted through the sealing ring.

In FIG. 17 it can be seen how the access channels 51' may be placed in the outermost lip portion 6 on the sealing ring, as they are distributed around the surface of the sealing ring when viewed in peripheral direction.

Many changes may be made without deviating from the spirit and scope of the invention as set forth in the appended claims.

We claim:

1. A pipe joint comprising bell and spigot pipes, the inner wall of said bell pipe (1') having a circumferential groove (2) defining a space in which a sealing means (3) is mounted said sealing means (3) comprising a sealing ring (4) preferably of rubber, having a substantially V-shaped cross-section when undeformed consisting of at least two lip portions (6, 7), and a stiffening body (5) in cooperation with said sealing ring (4) for holding one of said lip portions in said groove (2), characterized in that the sealing means (3) has portions (6, 7, 52, 51, 51A, 51B, 51') providing a compression seal between said pipes, the lengths of the lip portions (6, 7) of said sealing ring (4) being such that both lip portions, when seen from the mouth of the bell pipe end portion, extend further into the pipe than said stiffening body (5), and in that the dimensions of said lip portions (6, 7) are such that there is more volume of lip material behind said stiffening body (5), when viewed from the mouth of the bell pipe end, than there is room for in the space defined by the circumferential groove space confined by the adjacent part of the bottom (2) of the groove, the exterior of the spigot pipe (1a) to be inserted into the bell pipe (1) the rearmost sidewall (2') of the groove and the stiffening body (5), so that the lip material is a state of compression and deformation substantially fills up said space.

2. A pipe as claimed in claim 1, characterized in that one or both of the lip portions of the sealing ring has a circumferential bead or ridge (8) along its outer edges, i.e. substantially behind said stiffening body (5) when viewed from the mouth of the pipe end portion (1), the bead beind of essential height compared to the wall thickness of the lip.

3. A pipe as claimed in claim 1 or 2, characterized in that a lubricant (9) is provided only between said sealing ring (3) and the bottom of said groove (2).

4. A pipe as claimed in claim 3, characterized in that a lubricant (9') is provided between said sealing ring (3) and said stiffening body (5).

5. A pipe as claimed in claim 4, characterized in that the stiffening body surrounded by said lip portions (6, 7) is a stiffening ring (15) having one or more axial recesses, such as notches (16, 18, 19), extending radially and inwardly, and being formed so that the parts (10, 11, 17) of said stiffening ring around said recess or recesses may be pressed inwardly so that the stiffening ring may be deformed to a kidney-like shape (FIG. 4).

6. A pipe as claimed in claim 1 or 2, characterized in that the stiffening ring (14) has a substantially rectangular cross-section.

7. A pipe as claimed in claim 6, in which the stiffening ring (14) has two recesses (18, 19), characterized in said recesses (18, 19) being arranged in close proximity of each other.

8. A pipe as claimed in claim 1, characterized in that at least one side surface of the sealing ring lip portion (6) situated between said stiffening ring (5) and the bottom of said groove (2) has protuberances (26) and depressions (27), which are compressed and made smaller respectively in the radial direction of the pipe when both the sealing ring (3) and the stiffening ring (5) have been secured in their places in said groove (2) and the lip portions of said sealing ring have at the same time been deformed by the inserted pipe end.

9. A pipe as claimed in claim 8, characterized in that said protuberances (26) and said depressions (27) are situated on the side surface of said lip portion (6) abutting said stiffening ring (5) (FIG. 6).

10. A pipe as claimed in claim 8 or 9, characterized in that said protuberances are bumps (28), which together with corresponding depressions (29) are evenly distributed over one or more side surfaces of said lip portion.

11. A pipe as claimed in claim 8 or 9, characterized in that said protuberances (26) and depressions (27) consist of one or more continuous circumferential bulges (26) and corresponding circumferential depressions (27).

12. A pipe as claimed in claim 1 or 2, characterized in that the stiffening ring (5) completely or partially surrounded by said lip portions has at least one through aperture (37, 39, 40, 41) completely interrupting the peripheral continuity of said stiffening ring, and in that the outer lip portion (6) of said sealing ring (4) has an inwardly extending projection (38, 42, 43, 44) corresponding to each aperture in said stiffening ring (5), said projection being received into the respective aperture in said stiffening ring (5).

13. A pipe as claimed in claim 12, characterized in that the stiffening ring (35) is mounted in a circumferential auxiliary groove (36) in the outer or inner lip portion, said auxiliary groove (36) only being interrupted by the projection or projections extending radially inwardly from the outer lip portion (6).

14. A pipe as claimed in claim 1 or 2, and particularly suitable as a pressure pipe, characterized in that the sealing ring (4), in which a stiffening ring (5) is mounted, is formed so that at least in compressed state, when the spigot end (1a) of a second pipe has been inserted therethrough, said sealing ring shows an inner circumferential cavity (52), and in that the end of the sealing ring (4) farthest from the mouth of the pipe end portion (1) is provided with at least one access channel (51, 51a, 51b, 51') situated so that it brings the interior of the pipe (1, 1a) in communication with said circumferential cavity (52).

15. A pipe as claimed in claim 14, characterized in that the access channel or channels (51, 51a, 51b, 51') are formed at the free end of one or both of the lip portions of the sealing ring (4).

16. A pipe as claimed in claim 14 or 15, characterized in that the access channel or channels (51a, 51b) are formed in a head or ridge (8') on the free end of one, preferably the inner, lip portion (7), or of both lip portions.

17. A pipe as claimed in claim 14 or 15, characterized in that the access channel or channels (51a, 51b, 51') are formed in the end contact surfaces of the lip portions, which are compressed against each other.

18. A pipe as claimed in claims 14 or 15, characterized in that the access channels (51a, 51b, 51') are evenly distributed around the surface of the sealing ring (4) when viewed in peripheral direction.

19. A pipe as claimed in claim 18, characterized in that the stiffening body (5) is surrounded by the sealing ring (4) and serves to press said sealing ring tightly against the bottom of the groove (2).

* * * * *

Reference 4

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TODAY'S MAILING DATE 2-14-02
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PAT APP/PATENT/REEXAM/ITF# 09/965 983 CERT OF MAIL CERT OF SERVICE
OF Joseph G. Radzik
FOR Bellows Pipe Coupling
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BY: Angela Kupczak DATE: 2-14-02

PATENT

Box Non-Fee Amendment

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Patent Application of Joseph G. Radzik	: Group Art Unit: 3627
Conf No.:	5169	:
Appln. No.:	09/965,983	: Examiner: Not Yet Assigned
Filed:	September 28, 2001	:
For:	FERROUS PIPE COUPLINGS AND PRELUBRICATED COUPLING GASKETS	: Attorney Docket : No. **5903-337US**

INFORMATION DISCLOSURE STATEMENT

It is requested that the enclosed reference(s) listed on the attached Information Disclosure Citation Form PTO/SB/08/A be considered by the Patent Examiner in connection with the above-identified application and be made of record therein.

Independent consideration and acknowledgment of the enclosed reference(s) are respectfully requested.

Respectfully submitted,

Feb. 14, 2002 By: _____
(Date)

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Enclosures

Form PTO/SB/08A

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet 1 of 1

	Complete if Known
Application Number	09/965,983
Filing Date	September 28, 2001
First Named Inventor	Joseph G. Radzik
Group Art Unit	3627
Examiner Name	Not Yet Assigned
Attorney Docket Number	5903-337US

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Exr Initials	Include Name of first Author (in CAPITAL LETTERS), title of the article (where appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), volume-issue number(s), page(s), date (in parentheses). If a book, also include publisher and city and/or county where published	T
	Catalog sheet entitled "Victaulic Installation and Assembly Styles 77, 75 (Also 77-S, 77-A, 41, 44, 22, 31) Cut Grooved Piping Method for Standard Steel Pipe", Victaulic Co. of America, Easton, PA. A/8.3, 1 page (01/1976).	
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Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet | 1 | of | 1

	Complete if Known
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Exr Initials	Foreign Patent Document Country Code	Number	Kind Code (if known)	Name of Inventor or Applicant of Cited Document	Date of Publication of Cited Document MM-YYYY	T1

OTHER PRIOR ART - NON PATENT LITERATURE DOCUMENTS

Exr Initials	Include Name of first Author (in CAPITAL LETTERS), title of the article (where appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), volume-issue number(s), page(s), date (in parentheses) If a book, also include publisher and city and/or county where published.	T1
	Catalog sheet entitled "Victaulic Installation and Assembly Styles 77, 75 (Also 77-S, 77-A, 41, 44, 22, 31) Cut Grooved Piping Method for Standard Steel Pipe", Victaulic Co. of America, Easton, PA, A/8.3, 1 page (01/1976).	
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Examiner Signature	Mariana Colli	Date Considered	7/10/03

Reference 5

United States Patent [19]

Holt et al.

[11] **Patent Number: 5,070,597**

[45] **Date of Patent: * Dec. 10, 1991**

[54] **TUBULAR ARTICLE**

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[*] Notice: The portion of the term of this patent subsequent to Sep. 26, 2006 has been disclaimed.

[21] Appl. No.: **370,411**

[22] Filed: **Jun. 20, 1989**

Related U.S. Application Data

[63] Continuation of Ser. No. 22,444, Mar. 2, 1987, Pat. No. 4,868,967, which is a continuation-in-part of Ser. No. 835,066, Feb. 28, 1986, abandoned, Ser. No. 835,067, Feb. 28, 1986, abandoned, Ser. No. 835,074, Feb. 28, 1986, abandoned, and Ser. No. 907,200, Sep. 12, 1986, abandoned, which is a continuation-in-part of Ser. No. 757,212, Jul. 19, 1985, abandoned.

[51] Int. Cl.[5] H01B 19/00

[52] U.S. Cl. ..... 29/631; 428/34.9; 428/35.1; 428/35.7; 428/36.8; 138/103; 174/84 R; 285/97

[58] Field of Search ..... 29/631, 605, 870, 869; 428/34.9, 35.1, 35.7, 36.8, 36.9, 36.91, 36.92; 174/84 R; 138/103, 178; 285/97

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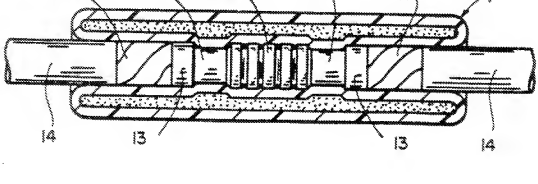
Primary Examiner—Carl E. Hall
Assistant Examiner—Carl J. Arbes
Attorney, Agent, or Firm—Edith A. Rice; Herbert G. Burkard

[57] **ABSTRACT**

A double-walled article in the form of a tube having a small volume filling of a friction-reducing liquid or solid between its two walls. The article is able to revolve over a substrate by relative sliding motion between its two walls, to provide environmental or electrical protection.

52 Claims, 15 Drawing Sheets



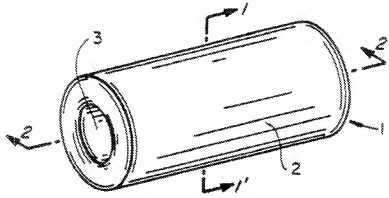


FIG_1A

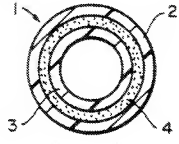


FIG_1B

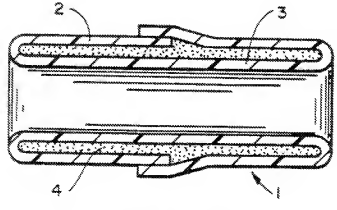


FIG_1C

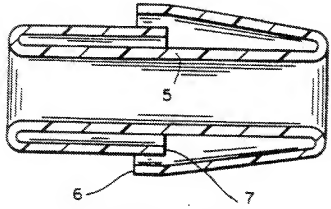


FIG_2

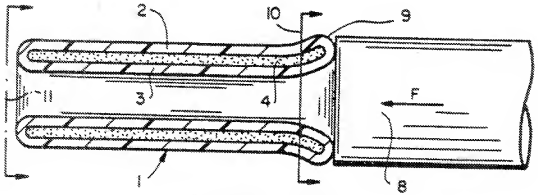


FIG_3A

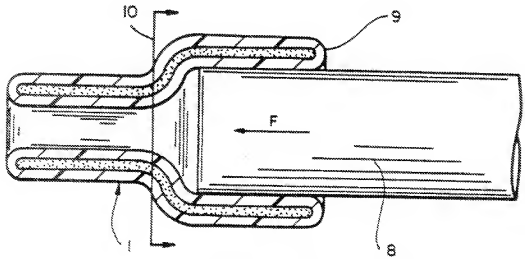


FIG_3B

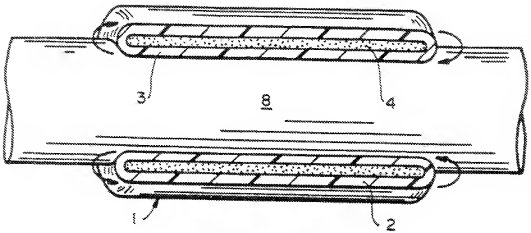


FIG_3C

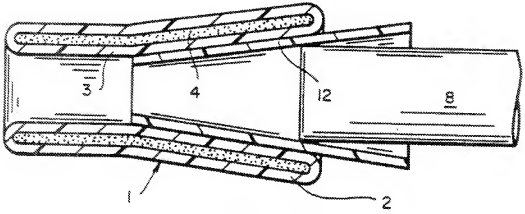


FIG_4

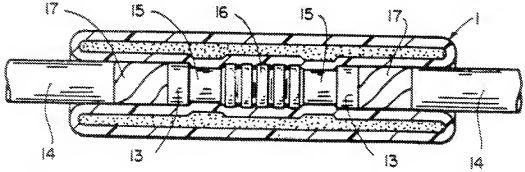


FIG_5

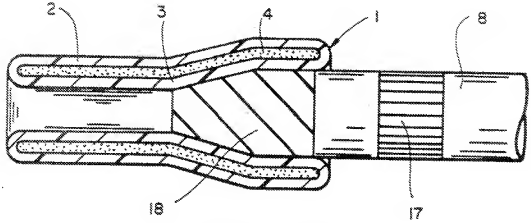


FIG_6A

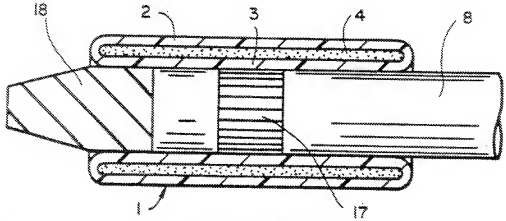


FIG_6B

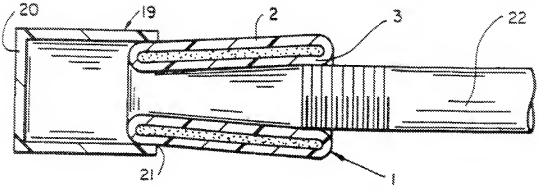


FIG_6C

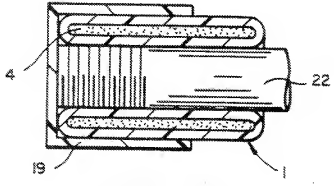


FIG_6D

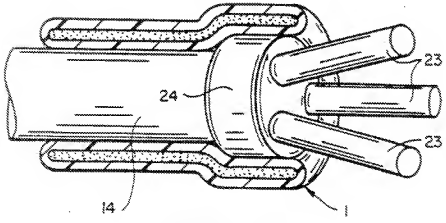


FIG_7

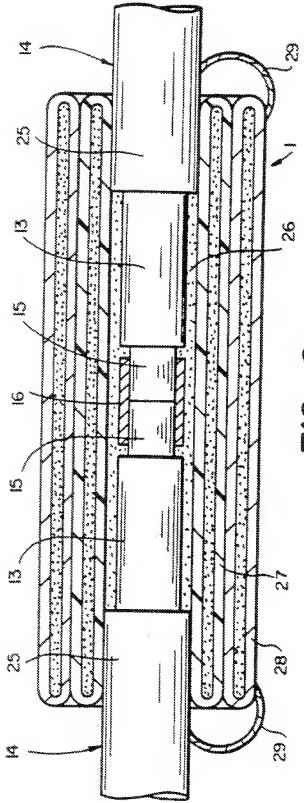


FIG_8

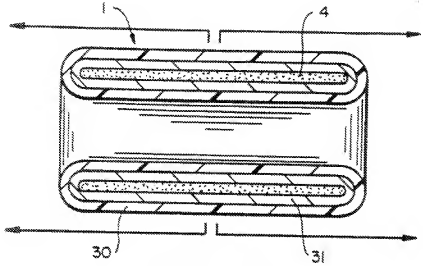


FIG_9A

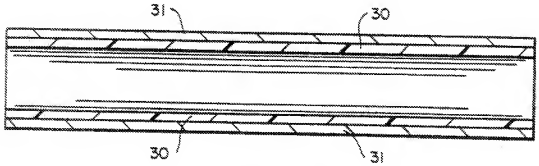


FIG_9B

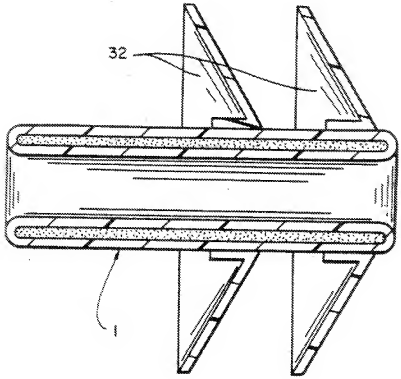


FIG_10

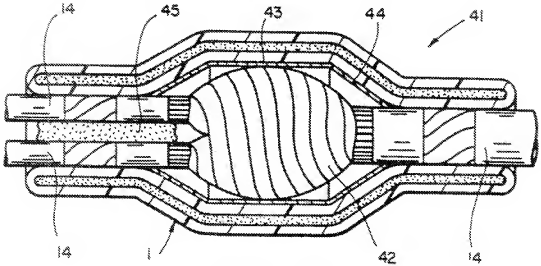


FIG_12

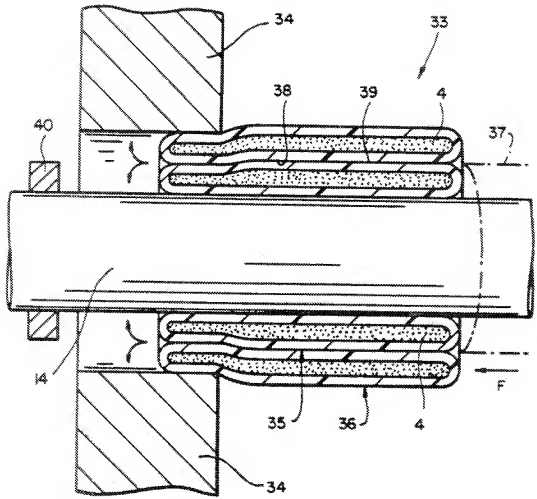


FIG_11

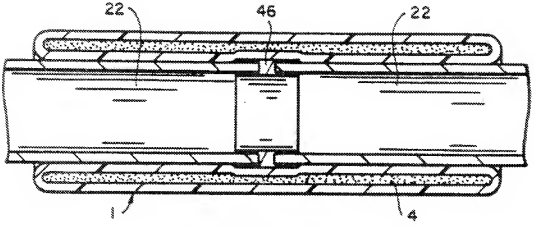


FIG_13

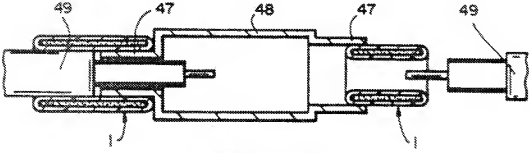


FIG_14

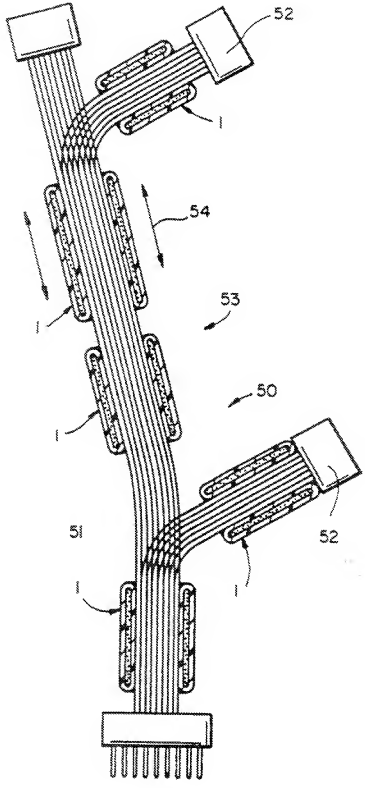


FIG_15

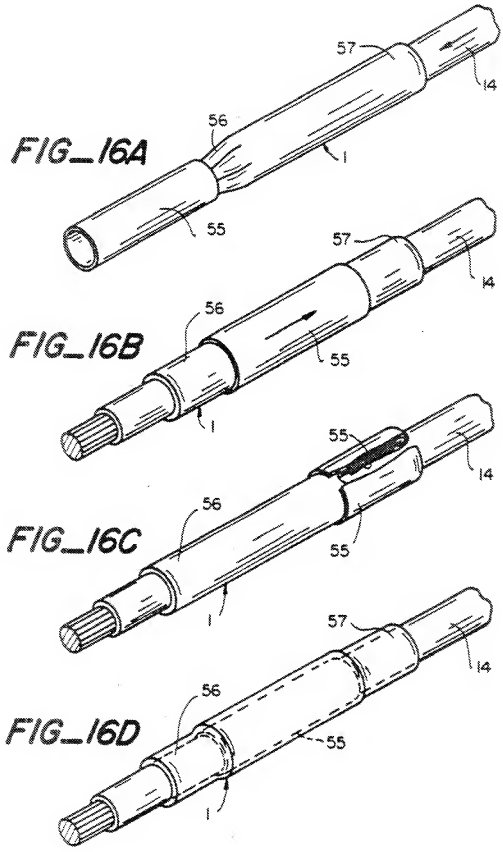

57
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FIG_16A
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FIG_16B
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FIG_16C
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FIG_16D

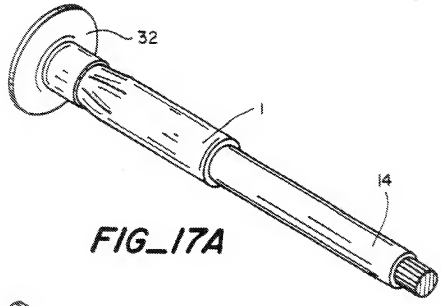

FIG_17A

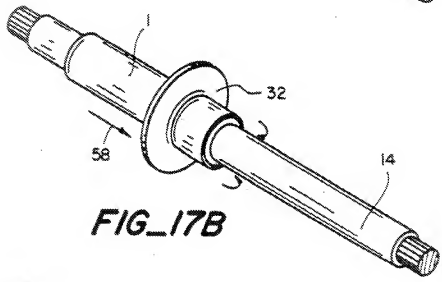

FIG_17B

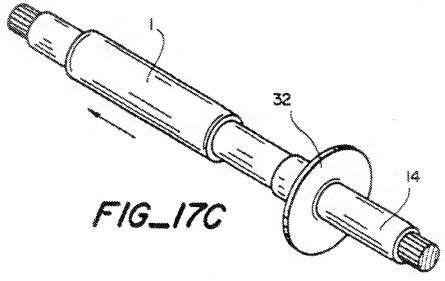

FIG_17C

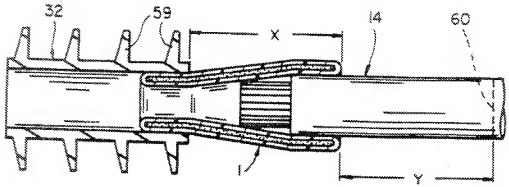

FIG_18A

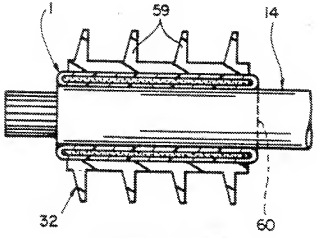

FIG_18B

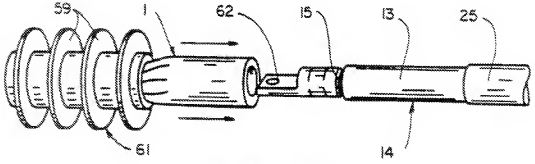

FIG_19A

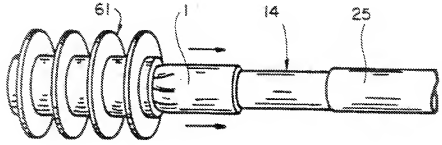

FIG_19B

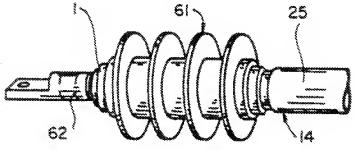

FIG_19C

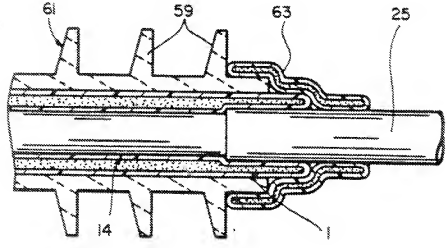

FIG_19D

TUBULAR ARTICLE

This application is a continuation of application Ser. No. 07/022,444, filed on Mar. 2, 1987, now U.S. Pat. No. 4,868,967, issued Sept. 26, 1989, which in turn is a continuation-in-part of application Ser. Nos. 06/835,066 filed on Feb. 28, 1986, now abandoned, and Ser. No. 06/835,067, filed on Feb. 28, 1986, now abandoned, and a continuation-in-part of Ser. No. 06/835,074, filed on Feb. 28, 1986, now abandoned, and a continuation-in-part of Ser. No. 06/907,200, filed Sept. 12, 1986, now abandoned, all of which are continuations-in-part of application Ser. No. 06/757,212, filed on July 19, 1985, now abandoned. The entire disclosures of these applications are incorporated herein by reference.

This invention relates to an article comprising a double-walled tube of a particular configuration, particularly one suitable for environmental protection, including electrical protection, and joining or mechanical holding of substrates such as cables and pipes. The article may also be useful as a blocking or delivery article.

Whilst the invention is not limited to any particular field of use, it finds particular applicability in the cable accessories and pipeline industries for protection and joining. Thus, the invention will be illustrated with reference to such uses.

It is often necessary to provide around a cable or pipe a covering to prevent environmental damage such as corrosion or to provide electrical insulation. The covering may comprise a tape-wrapping which, while applicable to a wide variety of sizes of substrates, requires skill for proper use, and even with skill is not long-lasting nor able to resist tough environments.

What is required is generally a tight fit over the substrate, an ability to be installed over substrates of various sizes, a certain life-time in service (in the cable accessories field often comparable to that of the cable, say thirty years) and some functional performance such as electrical insulation or water impermeability.

The poor sealing achieved with tapes has been overcome by the use of dimensionally-recoverable, generally heat-shrinkable, articles such as sleeves for example those disclosed in U.S. Pat. Nos. 3,086,242 to Cook et al, 3,279,819 to Wetmore and 3,455,336 to Ellis. Such articles, which are supplied in an expanded state, relax on heating. Thus a sleeve for example is easily positioned around a portion of a cable to be sealed, and is then heated causing it tightly to engage the cable. Shrinkage ratios of 3:1 or more are easily obtainable, hence any such shrinkable article may be used over a range of sizes of cable or over a cable of varying cross-sectional size. Heat-shrinkable articles have found wide us in the cable accessories and pipe-line industries and excellent performance can be obtained.

A disadvantage, however, remains. A source of heat must of course be provided, and this can in some circumstances be inconvenient. Furthermore, it has been customary, for all but the smallest heat shrink articles, to use a propane, or other open-flame, torch to cause shrinkage, which can be dangerous in some environments. For example, when a gas pipe or a cable running adjacent to a gas pipe is to be repaired, the gas supply may have to be shut-down and in some countries such uses of a torch are prohibited. Similar problems arise with mine cables.

This problem has led to a search for a cold-shrinkable product. Radially expanded elastomeric sleeves have been proposed that are held in an expanded configuration by means of a restrain. The expanded sleeve must then be separated from the restraint in such a way to permit it to recover towards its unexpanded configuration and into engagement with the cable or other substrate. Articles of this type are disclosed in U.S. Pat. Nos. 3,515,798 to Sievert, 4,070,746 to Evans et al, and 4,506,430 to Guzay. In the last of these an elastomeric sleeve is held in a radially expanded condition by an internal support. The sleeve is folded over itself with a lubricant between the folded layers. To apply the sleeve the upper layer is slid off the support onto the cable and the support is pulled in the opposite direction permitting the rest of the elastomeric sleeve to slide onto the cable. Application of a sleeve in this manner results in the lubricant being interposed between the sleeve and the cable. This can make sealing the sleeve to the cable using a sealant or adhesive difficult or impossible to achieve. Also, because the elastomeric sleeve is of necessity maintained in an expanded configuration during shipment and storage of the product, a problem known as "tension-set" arises. This problem is the tendency of the elastomer to become set in the expanded configuration such that on release from the restraint it does not fully recover to its original unexpanded configuration. A further disadvantage of this type of product is that the restraint adds to the cost of manufacture.

Another approach is to support the centre portion of an elastomeric sleeve in a stretched condition and roll the ends of the sleeve over the central support. In use the support and rolled-up sleeve are positioned over the substrate. Then the ends of the sleeve are unrolled bringing them into contact with the substrate. Such articles are disclosed in U.S. Pat. Nos. 3,875,320 to Mixon Jr. et al, and G. B. 2,099,638 to Pirelli. Again the article is maintained in an expanded configuration which can lead to tension-set.

A further approach is to use moulded separable connectors which provide an interference fit with the cable or other substrate to which they are applied. Each device must, however, be accurately sized to provide the necessary interference fit, and even then a seal can not be reliably made due to imperfection in the surface of the substrate. Such devices are generally referred to as "push-on" devices and an example is disclosed in U.S. Pat. No. 4,400,048 to Sacks.

Yet a different approach is disclosed in U.S. Pat. No. 3,897,088 to Beinhaur. There, a device similar to an inner tube for a tire is disclosed, whose diameter on inflation increases until it reaches a dimension greater than the outer dimension of the substrate over which it is to be installed. The device is then slid along the substrate to the desired position where it is deflated to cause it to engage the substrate. A disadvantage is the requirement for a tool in order to install or remove the device.

We have now discovered that tight engagement over substrates of various sizes can be achieved using a double walled tube that is able to revolve (to be explained below) and that is of a certain configuration and that has certain materials properties.

The mere idea of a double walled tube is of course known, for example from U.S. Pat. No. 3,978,531 to Bon and U.S. Pat No. 4,228,792 to Rhys-Davies. In the first of these, a double walled tube having a large volume of filling of gas between the two walls of the double wall is used for lifting a bed-ridden patient without hurting him. The tube is placed at the side of the patient

and perpendicular to him and a rod is pushed into the remote end of the tube. Friction between the inner wall of the tube and the rod causes the tube progressively to turn itself inside out, i.e. to revolve, as the rod is pushed. Thus, the tube creeps under the patient. It would appear to be essential that the revolving action of the tube results from a compressive action between the two ends of the tube, i.e. between the patient's body (and the surface on which he is lying) acting on the outer wall of the tube at one end, and the rod acting on the inner wall at the opposite end.

The second specification just referred to is also from the medical art. It discloses a double walled tube, again with a high volume filling between the walls, that is revolved along a patient's arm to drive blood out of it, allowing application of a tourniquet in preparation for surgery. Before use, the tube is inflated between its two walls to such an extent that the inner wall collapses and the outer wall expands.

Use of each of these prior art devices consists in the action of moving it to a position which it temporarily holds, shortly after which the device is removed. The device is not carrying out its function when statically in position around a substrate. We have designed such a device of a configuration and materials properties that allow it to provide, for example, environmental sealing and other functions useful in the cable accessories, pipeline and other industries.

Thus, the present invention provides an article comprising a double-walled tube that can be continuously revolved along an elongate member by relative sliding motion (which could be pictured as shear) between the two walls of the double wall, substantially without relative sliding motion between a wall adjacent the member and the member, the double wall:

(a) defining a closed region between its two walls;

(b) having between its two walls a friction-reducing means comprising a solid or a liquid;

(c) comprising an elastomeric material, preferably having a secant modulus at 100% elongation of less than 24.7 Kg. per sq. cm. (350 psi);

such that if said liquid is non-setting, the volume of the closed region is such that when the article surrounds a substrate of a size such that its wall adjacent the substrate is under a positive tensile strain the average separation between its walls is less than 10 times its average wall thickness; and the tube being of such configuration that it will buckle, preferably bellows buckle or column buckle, rather than revolve if subjected to an axial compressive force applied between an outer wall at one extreme end and an inner wall at an opposite extreme end.

The reference to buckling rather than revolving is to be interpreted as follows. The compressive force is to be considered as applied gradually increasing from zero to a value which will cause either buckling or revolving. Doubtless any article will immediately buckle if subjected to a severe enough impact; we are concerned however with reasonable installation conditions. The above definition requires buckling if the force is applied between the extreme ends, and the relative sliding motion required of the present double-walled tube may be achieved by applying a compressive force between an inner wall at one end and an outer wall at a position close to that end. This is explained below in connection with FIG. 3A. The prior art article U.S. Pat. No. 3,978,531 (Ikon) requires the end-to-end compressive force to result in a revolving action.

By continuously revolving we simply mean that relative sliding motion or shear between first and second walls of the double wall can be continued such that the first and second walls exchange position and then return to their original configuration. We require only that such a complete revolution be achievable once, although we prefer that it can be continued as many times as desired. (A curable composition may be provided between the walls and curing may limit the time during which revolving is possible.) Thus, the article may be revolved along an elongate member and left in any desired position. The first and second walls may of course be indistinguishable from one another, except for the fact that at any given time one is an inner wall adjacent the substrate and one is an outer wall overlying the inner wall. Then the portion of wall material that constitutes each wall will continuously change as the revolving action takes place. When we refer to a first, second, inner or outer wall we refer merely to a portion of wall identifiable for the time being by its position and do not imply that it has any structural uniqueness. The revolving action may be pictured best perhaps by imagining a longitudinal axial section of the double-walled tube over a cylindrical substrate. The tube will appear as a Caterpillar-track on either side of the substrate (Caterpillar is a trade mark). The tube can progress along the substrate by the Caterpillar-tracks revolving. This involves shear between the inner and outer walls constituting the Caterpillar-track, and will generally avoid shear between the inner wall and the substrate.

When we refer to the double-walled tube we do not preclude additional walls or layers, providing the revolving action is still able to take place.

The article may comprise components in addition to the double-walled tube itself. For example, the tube may be part of a larger device, such as a housing of which the tube comprises an outlet. In a second example, the article comprises some sealing means in addition to the tube itself. In a third example the tube may be provided with some means such as a frame with which it is stabilized. In a further example the tube is provided with means blocking a passage therethrough such that the article may be used as an end cap. In this case the tube itself, although generally not the article, will be capable of continuously revolving as referred to above.

It is preferred that the tube has substantially uniform properties, particularly unstressed circumference (it may, but need not, be circular in cross-section), through substantially the length of its inner and outer walls. This is preferred in order that the article will have the same functional performance, for example sealing properties, irrespective of the position along a substrate onto which it is revolved. Such uniformity of unstressed circumference will result if the double-walled tube is produced by turning a flexible tube inside-out (or outside-in) along half of its length so that originally opposite ends are joined together. The friction-reducing means is provided within the resulting double-wall. The double-walled tube may be made by joining together respective ends of two concentric tubes; in this case there will generally be a difference in unstressed circumference between what is initially the inner and what is initially the outer wall, but it need not be substantial. Preferably the maximum unstressed circumference along the inner and outer walls is less than 20%, more preferably less than 10%, especially less than 5%, particularly less than 2% greater than the minimum unstressed circumference, based on the minimum.

The article of this invention may be of any length, and it will generally be less than 30 m (100 feet) and more frequently less than 15 m (50 feet). Typically articles of this invention are from about 5 cm (2 inches) to about 130 cm (50 inches) in length, and in particular are from 13 cm (5 inches) to 80 cm (30 inches) in length depending on the substrate over which they are to be used.

The outer diameter of the article similarly can be of any desired size, and typically is less than 125 cm (50 inches) generally less than 50 cm (20 inches), preferably from 2.5 cm (1 inch) to 15 cm (6 inches) depending on intended use. The inner diameter is preferably from 0.2 cm-120 cm, more preferably 0.5 cm-50 cm, especially 1 cm to 10 cm.

The ratio between the length and outer diameter of the article will also depend on the use to which it is to be put. We prefer, however, that that ratio is more than 5, more preferably more than 7, especially more than 8. Typical values are from 8-12. Articles of such shape, particularly with a low volume of friction-reducing means within the double wall, will tend to buckle (rather than revolve) if subjected to an axial compressive force applied between an outer wall at one extreme end and an inner wall at an opposite extreme end. As a result a preferred technique whereby articles of the invention are installed is as follows: the revolving action is at least initiated by applying a shear force between the inner wall at one extreme end (by means for example of an end of a substrate to be covered) and the outer wall at a position a short distance, say less than 7 cm, preferably from 0.5-3 cm, from that same end (by means for example of an installer's hand). This technique is particularly relevant to a preferred use of the article where both the inner and outer walls are under tension when the article is installed on the substrate, as is required if an environmental seal is to be reliably achieved. Both the inner and outer walls must therefore be expanded as the article is revolved onto the substrate, and that portion of the outer wall which is over the substrate will generally be under greater tension than the remainder that has yet to reach the substrate. This difference in tension will tend to drive any fluid separating the inner and outer walls towards the end of the article yet to reach the substrate, i.e. towards the end of less tension. The inner and outer walls at the end over the substrate will cease to be separated, and friction will bring the revolving action to a stop. Hence the preference for the means, to be discussed below, restricting displacement of the friction-reducing means. It may be noted here that the high filling volumes disclosed in connection with the superficially related double-walled articles of the prior art, required there because of the different functions and installation techniques of those articles, obviate this problem of displacement of any fluid separating the walls. The reason is that the outer diameter of the article is in general larger than that of the substrate, and the inner wall is initially collapsed completely and does not need to be expanded for the article to function as disclosed.

When the article has been revolved onto a substrate of such a size that its wall adjacent the substrate is under a positive tensile strain, we prefer that the outer diameter of the tube (i.e. of the outer wall) is 1.5 or less, preferably 1.3 or less, especially 1.2 or less, times the inner diameter of the article (i.e. of the inner wall). Most preferably they are substantially equal since the separation between the walls is preferably small, as mentioned above, and the wall thicknesses are also preferably small compared to the diameter of the tube. The separation between the walls was given above as less than 10 times the average wall thickness, and preferred values are less than 8, especially less than 5, particularly less than 2, more particularly less than 1, and generally greater than 0.0003, typically from 0.001 to 0.5.

The inner and outer walls are each preferably from 0.0025 to 1.3 cms (0.001 to 0.5 inches) thick, more preferably from 0.05 to 0.65 cms (0.02 to 0.25 inches), and most preferably from 0.15 to 0.25 cm (0.05 to 0.1 inch) thick. The material comprising the walls should of course be sufficiently flexible that the revolving action may take place, and it preferably has an elongation to break of at least 20%, more preferably at least 40%, especially at least 100%, more especially at least 200%, particularly at least 500%, more particularly at least 700%. These figures relate to the ASTM test D412-83.

The degree to which the walls of the article may be stretched will determine the maximum size of substrate over which the article may be installed. Preferably, the outer diameter of the substrate is from 1.0 to 8 times the inner diameter of the article of the invention. Preferred ranges are from 1.1 to 5, especially from 1.1 to 2.5. Where the article is to be used, for example to seal a cable or pipe and a separate sealing material, such as a mastic, is used to enhance the seal, the diameter of the substrate should be taken as including the sealing material. For some uses, for example delivery of an expandable article over a substrate, a seal between the article of the invention and the substrate may not be desired, and the inner wall need not then be under a positive tensile strain when over the substrate. In such instances the inner diameter of the article may be greater than the outer diameter of the substrate. The substrate outer diameter is then preferably at least 0.75, especially at least 0.9 times the inner diameter of the article.

The ease with which the article can be installed over a substrate of larger size will depend on the tensile stress of the material comprising the walls. We prefer that the article can be installed by hand over substrates having the size ranges given above, using the technique disclosed above whereby a shear force is applied between the end of the article and a position close to that end. We prefer that the material has a secant modulus at 100% elongation, as determined by ASTM D412-83 of 21.1 Kg. per cm^2 (300 psi) or less, more preferably 14.1 Kg per cm^2 (200 psi) or less, particularly 10.6 Kg per cm^2 (150 psi) or less, especially 9.2 Kg per cm^2 (130 psi) or less. A useful range is from 5.6 to 10.6 Kg per cm^2 (80-150 psi). A Shore A hardness as measured by ASTM D2240 of less than 90, preferably less than 60, more preferably less than 40, will be preferred for many uses. The material preferably has an ultimate elongation to failure of at least 150%, more preferably at least 500%, especially at least 900%. A low temperature brittleness as measured by ASTM D746 of −20° C. particularly −40° C. is preferred.

The material comprising the double-wall will be chosen from at least two considerations. Firstly it must allow the revolving action necessary for installation onto or use along a substrate of a certain size or shape or substrates of a certain range of sizes and shapes. The properties of interest here will include flexibility, tensile stress at a chosen elongation, elongation to break and ability to retain the friction-reducing means. The second consideration is the functional requirement of the installed product. For example, if it is required to pro-

vide environmental protection it may need a certain mechanical strength, abrasion resistance, cut resistance, moisture impermeability, etc. If it is to have an electrical function it may be required to be of high resistivity as an insulator, of low resistivity as a screen or other conductor, of intermediate resistivity as for stress-grading. It may have a certain specific impedance at a certain frequency. It may need anti-tracking properties, or it may need resistance to corrosion under high electrical discharge, etc. Where it is to be used in difficult environments it may need compatibility with certain sealing materials, U.V. resistance, fungal resistance, oxidation resistance, resistance to stress-relaxation, flame resistance, resistance to solvents, or low water up-take, etc. Such features are known to be required of certain prior art products, for example heat shrinkable sleeves, and the man skilled in the art of polymer formulation will know how to prepare suitable materials. After reading this specification he will be able to prepare various new and inventive articles that combine the ability to be installed by the revolving action described herein, and any one or more of the above functional requirements.

Examples of elastomers that may be employed to form the walls of the article include: natural rubber, polyisobutylene, polyisoprene, isobutylene-isoprene copolymers, polybutadiene, styrene-butadiene copolymers, ethylene-propylene copolymers, ethylene-propylene diene terpolymers, polychloroprene, acrylic rubbers such as ethylene-ethyl acrylate copolymers, epihalohydrin homopolymers and copolymers, nitrile rubbers such as acrylonitrile-butadiene copolymers, silicone rubbers such as polydimethyl siloxane, polysulphides, fluorocarbon elastomers such as hexafluoropropylene-tetrafluoroethylene co- and ter-polymers, polyurethanes and the like. Thermoplastic elastomers such as segmented polyether ester block copolymers, polyester urethanes, polyether urethanes, and the like may also be used. The polymeric material may contain a plasticizer, such as an oil, reinforcing fillers, stabilizers, flame retardants, additives to improve the electrical properties such as anti-tracking additives or conductive particles and the like. A preferred polymeric material for certain uses is disclosed in commonly assigned patent application Ser. No. 020 633 filed 3/2/1987 filed concurrently herewith, the disclosure of which is incorporated herein by reference. The polymeric material may, but in general will not, be heat-shrinkable to produce additional compressive force on the substrates. The material may be cross-linked, for example chemically or by electron beam radiation.

Other materials that may be incorporated include thermoplastic polymers such as elastomers, or metals, for example aluminum or steel. Metals are preferably used in the form of a foil having a thickness from 0.00025 to 0.013 cm (0.0001 to 0.005 inches). Such foils are sufficiently flexible and, if desired, can be elastically and/or plastically deformed, for example by corrugation. These materials may be used alone, as strips or other regions, interspersed with strips or other regions of elastomer, laminated or deposited over part or all of an elastomeric wall, or in other ways. A metal layer may be provided for example as a moisture vapour barrier, or to render the article conductive for the purposes of providing an electrical screen etc. The foil is preferably located as close as possible to the material axis of the tube.

The walls may comprise a fabric, for example a braided, or woven or knitted tubular fabric, optionally together with a matrix material by means of which it is rendered substantially impervious. One or two or more different fibres may be used. In general the following fibres may be incorporated: elastomeric, thermoplastic, cellulosic, proteinaceous, glass, ceramic, metallic, or the like, or mixtures of these. The construction of the fabric preferably permits radial expansion of the double-walled tube. Heat-recoverable fabrics may be used to provide additional compressive force on the substrate. Where suitable, the elastomers listed above may be used in fibrous form.

The walls may comprise a composite material, for example an elastomeric material reinforced with fibres or with a fabric. The reinforcing fibre may comprise polymeric, glass, cellulosic, carbon, graphite, metallic, ceramic or the like materials. The fibres may be oriented, for example axially with respect to the tube, for improved tensile strength. Furthermore, the walls may comprise segments, for example strips, of different material to provide different properties along the walls, if desired. The walls should, however, in general be sufficiently flexible over their entire surfaces that the revolving action can easily occur.

Each wall of the double-walled tube may comprise a plurality of layers of material formed, for example, by lamination or co-extrusion. For example, one or both of the inner and outer walls may comprise an interior layer (i.e. the layer facing the closed area within the double-wall) of, say, butyl rubber which is an effective gas diffusion barrier or a metal layer as mentioned above, and an exterior layer of, say, ethylene-propylene-diene terpolymer rubber which has excellent weathering properties. Similarly, a combination of electrical properties or chemical properties may be provided.

The two walls that make up the double-wall may comprise the same or different materials, and be of the same or different thicknesses. If they are to be of the same material and thickness it may be preferred to make the article by partially turning a single tube inside-out, or outside-in, and joining its ends together. Where the two walls are to differ, another technique may be preferred, such as joining together respective ends of two concentric tubes. Such tubes may be made for example by extrusion or moulding.

The joints between the ends may be permanent or of a temporary nature, for example by means of a recoverable clamp or patch. The ends may be joined directly or by the use of one or more additional segments of material preferably flexible, between them. Such a segment may for example comprise a tubular strip of slightly smaller or larger diameter than the tube ends to be joined, and may be positioned to bridge a butt joint between those ends. Thus, the article may contain such segments additional to those of the double walled tube proper.

When the ends of the tube or tubes are joined together in this fashion a double-walled tube is produced having a closed space between the walls. The friction-reducing means may be supplied before the ends are joined (this includes embodiments where the surfaces of the tube or tubes have been treated or where they inherently have low-friction surfaces which then may constitute the friction-reducing means) or the friction-reducing means may subsequently be inserted through a sealable opening such as a valve. The inner and outer walls are then capable of relative shear as the article revolves axially. The article need not be restricted to axial mo-

tion, and a certain degree of radial and/or circumferential relative motion between the walls may be possible.

The friction-reducing means will in general require some means to prevent or restrict its own displacement at least during initial revolving action onto a substrate. Before preferred examples of the friction-reducing means are given therefore, the means for restricting displacement will be explained since in preferred embodiments it is a property of the friction-reducing means rather than something physically separate. The reason for uninhibited displacement of a separating fluid possibly being a problem in the context of the present invention, but apparently of no concern in the prior art, was discussed above, but may be repeated here. When both walls have to be expanded as the article is revolved over an end of a substrate, a separating fluid has a tendency to be driven away from that region of the tube subjected to greatest expansion which, unfortunately, is where it is needed. This problem is not noticed with a high volume filling where expansion of the inner wall is not required since the substrate may have a diameter smaller than the diameter of the outer wall, and in any case there is a vast amount of separating fluid present. Such an article is however wholly unsuitable for solving the problems that the present invention addresses.

Whilst we wish not to be bound by any theory, we believe that the friction-reducing means, when a liquid, serves by maintaining hydrodynamic lubrication, presumably in addition to boundary lubrication. We prefer that lubrication can be maintained between the two walls of the double-walled tube under a pressure gradient of 27 kPa per cm. In the absence of the means for restricting, substantially all separating fluid may be displaced, possibly leaving an adsorbed mono-molecular layer of lubricant at each surface. The conditions under which hydrodynamic lubricanon (or whatever phenomenon is responsible) must be maintained will of course depend on the particular application but the following information may be helpful. Displacement of friction-reducing means may be rate dependent, and a very quick installation may be successful where a slow one is not, simply because less time is available for the friction-reducing means to be displaced. Nonetheless, some means for restriction will be preferred and a simple gas (which is preferred in the prior art double-walled tubes, but whose sole presence is excluded from the article defined above) being perfectly fluid and having no means to prevent its displacement will generally not function as desired, however quickly one attempts to install the article. Furthermore, the speed at which one is able to install the article will depend on its size, and on the shape and size of the substrate over which it is to be revolved. The article may be used to install an elastomeric article over a substrate under conditions where the elastomeric article has to be stretched, and the tendency for the lubricant to be displaced must again be taken into account. If the substrate has any sharp changes in size along its length (known as transitions in the cables art) such as may occur at a cable splice and of course at an end of a cable, the problem may be particularly acute since the effect may be to wipe the friction-reducing means away from the leading end of the double-walled tube. A further consideration is whether the article is to be installed once and left installed, or whether subsequent removal (referred to as re-entry in the cables art) is likely. In the latter case it is desirable that any transitions over which the installed article is to lie to do not cause total displacement of friction-reducing means such as would prevent re-entry. If this is found to have happened, re-introduction of friction-reducing means to the desired portion of the tube may be possible by massaging the tube or by other means. It can be seen therefore that this long-term restriction of displacement is not essential, and in many instances may not be possible, bearing in mind that many years may elapse between installation and re-entry.

The friction-reducing means may be restricted from displacement by its being physically attached to the inner and outer walls. For example, the walls may have a low friction coating. A second possibility is the provision of some means that deforms a second region of the article, preventing flow of friction-reducing means away from a first region where it is needed.

We prefer, however, that the friction-reducing means is a liquid having such rheological properties that it can continue to provide hydrodynamic lubrication under the conditions described herein. We prefer also that the liquid wets the surfaces of the wall of the double-walled tube, preferably at a dihedral angle of less than 80°, more preferably less and 45°, especially less than 30°. The correct rheological properties and the ability to wet the walls result, it is thought, from some sort of weak bonding network throughout the friction-reducing system to the walls that allows the walls to slide past each other in shear but resists displacement of the friction-reducing means that would otherwise occur due to the tension in the outer wall and the force of installation which effectively forces the two walls together.

Preferred behaviour of the lubrication system is reflected in such properties as the change in viscosity with shear rate. We prefer in fact that the friction-reducing means is a non-newtonian particularly highly non-newtonian liquid (which term includes semi-solid). It is preferably pseudo-plastic (viscosity decreases with increasing shear) and/or is a bingham fluid (which means that it has certain non-zero yield stress). Preferably the viscosity at 20° C. is less than 10,000, especially less than 5,000, particularly less than 1,000 centipoise at shear rates of greater than or equal to 100, particularly greater than 500, especially greater than 1,000 reciprocal seconds. We also prefer that the viscosity at 20° C. at a shear rate of 1 reciprocal second is greater than the following, in order of ascending preference : 1, 50, 100, 200, 5,000, 10,000 centipoise.

We have discovered that in addition to preferred absolute values of viscosity the rate of decrease of viscosity with shear rate, i.e. the degree of non-newtonian behaviour, is important. We particularly prefer that, at least over a range of from 1-100 reciprocal seconds, the viscosity drops by at least a factor of 5, 10, preferably 15, especially from 15-30. This factor is not particularly temperature dependent, and we prefer that it holds at 20° C.

A further property desirably possessed by the friction-reducing system is pituity. This property is related to the cohesive strength of the liquid and can be pictured as stringiness. It may be quantified in terms of extensional viscosity.

Pituity may be measured as follows. A sample of the liquid to be tested is placed in a tin can approximately 0.5 liters and of approximately 8 cm diameter, to a depth of at least 5cms. A blade is inserted in the liquid and the force required to remove it is measured using an Instron (trade mark) Tensometer model 112 equipped with a 2 kg load cell. The Instron is calibrated to 100 grams full

scale. The blade (which preferably has at least one hole therethrough to increase drag caused by the liquid) is placed vertically in the upper jaw. At 100 grams full scale the Instron recording pen is set to zero. The scale is then changed to 20 grams full scale and the pen re-balanced to zero. A chart recorder set to 200 mm per minute is found to be suitable for recording the results. The can with the liquid is placed under the blade so that the blade is centred. The cross beat is moved so that the blade just contacts the surface of the liquid, and this is done at an approach speed of 20 mm per minute. The counter is set to 000 mm, the cross head to 50 mm, and the stop mode is activated. The liquid is then entered, when the minimum limit is reached a stopwatch is started. The counter is reset to 000 mm, the minimum limit is deactivated, and the cross head speed is set to 1000 mm per minute.

After 25 seconds the recording chart and the pen are started. After 30 seconds the cross heat is started in an upwards direction.

The force is recorded as a function of time. The curve obtained shows a sharp spike indicating a sudden force which then dies. This is due to the inertia of the blade. The spike may be ignored. The force then rises quite sharply with time to reach a peak value (Fp grams) and it then decreases gradually. Down to some residial value which represents the weight of the liquid remaining on the blade after it has been removed from the bulk of the liquid.

The peak force (Fp) and the area under the curve as defined by this test give an indication of the pituity of the liquid. The area under the curve is taken as the area bounded by the upper part of the curve and the time axis and a straight line extension of the rise side down to the time axis, and tangent to the inflection point of the fall side down to the time axis. The area is given herein as E in units of grams second. Three measurements of each liquid are to be made, if possible, and an average taken.

We prefer that the friction-reducing means has a pituity given by Fp greater than 1 gram, preferably greater than 1.5 grams, especially greater than 2 grams, particularly greater from 1.5 to 7 grams, more particularly greater than 10 grams. The value will generally be less than 30 grams.

The value of E is preferably greater than 4 grams, especially greater than 5 grams, particularly greater than 10 grams, more particularly from 15 to 100 grams. The value will generally be less than 200 grams.

We prefer that the friction reducing means has an Fp value within the above ranges and an E value within the above ranges.

The above properties of the friction-reducing means should apply under installation conditions, particularly at ambient installation temperatures which may range at least from −40 to +60° C. but is more usually −10 to +25° C., and they are desirably maintained if re-entry is desired. In many instances however the article may experience high temperatures during service which may alter the properties of the friction-reducing means, for example pituity may be reduced after high temperatures or prolonged lifetimes. The man skilled in the art after reading this specification will be able to design a suitable lubrication system where loss of pituity is minimized. A shelf-life of 1 year at 50° C., especially 2 years at 60° C., is preferred.

The following liquids (which term includes compositions often referred to as gels) may be used as the friction-reducing means: a polyhydric alcohol such as glycerin or a glycol, or polyhydric alcohol-based or water based solutions containing a soluble polymer such as a polyacrylate, poly-methacrylate, polyacrylamide, polyethylene oxide, polyamide, polyamines, guar gum, xanthum gum, alginate, maleic anhydride copolymers, polyvinyl pyrrolidone, polyvinyl alcohol, cellulose derivatives such as hydroxypropyl cellulose, carboxy methyl cellulose and hydroxy ethyl cellulose; oils, such as silicone oils, hydrocarbon oils, mineral oils and vegetable oils. Where solutions, or other combinations of a dispersed and a continuous phase, are used, dispersing, solubizing, gelling or other stabilizing agents may be used. Such agents are thought to act by making possible an extended weak hydrogen-bonded or ionic-bonded matrix throughout the liquid that can be ruptured by shear.

Preferred solutions having a high pituity comprise very dilute solutions of very high molecular weight, generally slightly gelled, polymers. Molecular weights greater than 2 million, especially greater than 4 million are preferred, and concentrations from 1 to 8%, especially 2-6%, particularly about 3% by weight are preferred. A commercially available example is an aqueous lubricant called Polywater F TM from American Polywater Corp. of Stillwater Minnesota.

Thickened aqueous or non-aqueous polymeric solutions are however preferred. A first example is a solution comprising about 90% by weight propylene glycol, 0.05 to 5% preferably about 0.5% by weight slightly anionic polyacrylamide having a molecular weight greater than 6 million, and the remainder water. The primary function of the water is as a solubilizing agent for the polyacrylamide. A second example is a solution comprising 0.05 to 5% by weight polyethylene oxide in water. A third example is a solution comprising 0.05 to 5% of polyacrylamide in water. Further ingredients such as biocides, boundary lubricants or stabilizers may be added.

The intended use of the article of the invention may restrict the type of lubrication system that can be used. For example, if the article has to be installed at high temperatures or will experience high temperatures once installed, it may be desirable to use a lubrication system based on a liquid of low vapour pressure at such temperatures in order to avoid inflation or bursting of the double-walled tube. A particular instance is the use of the article over a high voltage cable, for sealing a splice or for other purposes. Whilst such cables are intended to operate at about 90° C., higher temperatures can arise and accessories used in conjunction with such cables are expected to be operable up to 130° C. Thus, we prefer that the article of the invention can function at 130° C. and in particular that the lubrication system has a vapour pressure at 130° C. that is insufficient to expand significantly the walls of the double-walled tube. Preferably therefore the lubrication means has a boiling point of greater than 130° C. under the conditions pertaining within the double-wall, and we further prefer that its vapour pressure at 130° C. is less than 1 bar.

Further desired properties of the friction-reducing means include low or zero permeability through the walls of the double-walled tube, and low toxicity.

In some embodiments solids or semi-solids may be preferred. Semi-solids that can be used include greases, pastes and the like. Examples of greases include those having NLG ratings of 00 or 000, such as MAG-00

manufactured by Fiske Brothers Refining Co. of Toledo Ohio.

Solid materials that may be used include particulate materials, for example powdered talc, corn starch, graphite powder, glass beads, ceramic beads, polymeric beads, for example of polytetrafluoroethylene, metal balls, for example of iron or low melting alloys or the like that can impart conductive or magnetic properties etc. to the article. A continuous solid friction-reducing means may also be used as an integral part of or adhered to or may comprise the interior surface of at least part of one or both of the walls. The solid is preferably one that has a good lubricity or relatively low coefficient of friction, for example ultra high molecular weight polyethylene, polytetrafluoroethylene etc.

Where the lubrication system is other than an integral part of the walls, the amount of it is preferably determined in terms of its thickness as discussed above. In addition to that determination, it is preferred that its weight is preferably less than 10 times the weight of the walls of the double-walled tube, more preferably less than 5 times, especially less than 1 times, particularly less than 0.5 times.

If greater amounts of friction-reducing means are used the double-walled tube may balloon or form an aneurysm when the article is applied over a substrate, particularly if the substrate is of significantly larger diameter than the diameter of the inner wall.

In other words, if too much lubrication system is present for the walls to be able to maintain it substantially uniformly distributed, installation may become difficult or impossible over certain substrates. Also, failure at a bond or other join between the inner and outer walls may occur.

In some instances it may be desirable that the lubrication system hardens after the article has been installed. Such hardening may be reversible as may be useful if re-entry is required. When hardening takes place the extent of filling between the walls may be greater than where it does not since a stable and tough installed product may still be obtained. The hardening may result from chemical curing, for example of a latent curing adhesive system within the double wall. Such a curing system may comprise the lubrication system or it may be in addition to it. Examples of curing systems include epoxies, acrylics and polyesters and RTV silicones. Cure may be initiated by application of heat, destruction of a physical barrier that separates the curing components, mechanical mixing of the components, introduction of an accelerator, introduction of one or more of the curing components, application of an electric or magnetic field etc. either prior to or after the article has been positioned as desired on a substrate. Such systems generally cure to form a highly cross-linked structure which is sufficiently rigid to prevent further revolving action and to form a mechanically strong or pressure-retaining enclosure around the substrate.

Other hardenable systems include fusible materials for example metals and hot-melt adhesives, which may be heated before installation and then merely allowed to cool.

The article may be used in conjunction with a sealing material or other means to prevent or restrict its revolving action once properly installed on a substrate, or to provide or supplement an environmental seal, for example against ingress of water or other contaminant, or for pressure retention within the substrate

For example, revolving may be prevented or restricted by mechanical means such as a blocking element placed at an end, or preferably both ends, of the article, or by taping an end of the article to the substrate, or by application of a clamp such as a hose clamp around the article, or, depending on the friction-reducing means, by puncturing the outer or inner wall or otherwise releasing the friction-reducing means.

A sealing material may be provided between the inner wall and the substrate or between the outer wall and some other object with respect to which movement is to be prevented. Such sealing material may be supplied on a surface of the substrate, on a wall of the article or as a discrete component that is positioned as desired during installation of the article. For example, the sealing material may be provided in sheet form (which includes tapes, strips and bands), either alone or on a backing material, which may be wrapped around the substrate.

The combination of the article and a sealing material is a beneficial one. It is of course known to provide environmental protection by means of a sealing material and some prior art cover whose function is to deliver the sealing material or to maintain it in position around a substrate against any mechanical forces that would displace it. The cover is desirably tight-fitting and is able to apply some compressive force to the sealing material; installation, of course, is therefore a problem since any sliding action will tend to drive the sealing material away. The problem is overcome by the use of the heat-shrinkable sleeves mentioned above, but they of course have the disadvantage in practice of requiring use of an open flame.

The article of the invention is able to apply a compressive force to a sealing material, forcing it against a substrate, whilst avoiding any shear that would tend to displace it during installation. This is of course due to the revolving action whereby relative sliding motion occurs between the inner and outer walls, rather than between the inner wall and the substrate. Thus, the article may be used to deliver to or otherwise to force a sealing material against a substrate, after which the article may be removed or left in place. The article could also be used to deliver or otherwise to force a sealing material against the inside of a pipe or against some other concave surface.

Sealing materials that may be used with the article for sealing or locking purposes include adhesives, sealants, gels and cement, mortar or concrete, etc. The sealing material may be in any suitable form, but it is preferably solid or semi-solid, especially in tape or block form.

Adhesives include contact adhesives, pressure-sensitive adhesives, curing adhesives and hot-melt adhesives (the advantage of the invention over heat-shrinkable materials need not be removed by use of an adhesive requiring heat since the temperature and quantity of heat required may be much less). Particularly useful pressure sensitive adhesives in tape form are disclosed in GB 2,133,026 (Raychem). Curable adhesives may comprise for example epoxies, acrylates or unsaturated polyesters, an anaerobic adhesive such as cyanoacrylate being specific example. One component of a two or more part curing adhesive may if desired be placed on the substrate, and another component on a wall of the article, for example the outer wall since that will become the inner wall in contact with the substrate after a certain extent of revolving. Curing adhesives should be selected to provide the desired shelf-life etc.

Preferred sealants include mastics, oils and greases such as those disclosed in U.S. Pat. No. 3,297,819 to Wetmore, which comprises substantially non-crystalline materials generally having a viscosity of not more than 10^{13} centipoise at 25° C. Such a material may flow under the compressive force provided by the article of the invention to fill any voids or other leak paths to the underlying substrate. This ability to flow means that the resulting environmental seal will be tolerant of small degrees of movement of the substrate (such as bending and thermal expansion and contraction, and vibration, etc.) and any small voids that may form may self-heal under the continued tension provided by the article.

A third, and preferred, category of sealing materials that may be used with the article is a gel, by which we mean a material preferably having a cone penetration of from 50 to 500 (10^{-1} mm) and an ultimate elongation of at least 100%. Cone penetration values are as determined by a method based on ASTM D217-68 at 21° C. (70° F.) ±2° C. on an undisturbed sample using a standard 1:1 scale cone (cone weight 102.5 g and shaft weight 47.5 g), the penetration being measured after 5 seconds. The ultimate elongation values are as determined by a method based on ASTM D638-80 at 21° C. (70° F.) ±2° C. at a speed of 50 cm per minute.

Preferably the cone penetration is from 100-350 (10^{-1} mm), more preferably from 150-350 (10^{-1} mm). We prefer that the ultimate elongation is at least 200%, more preferably at least 500%. Furthermore, we prefer that the gel has an elastic modulus of less than 10^8 dynes/cm^2, more preferably less than 10^7 dynes/cm^2, particularly less than 10^6 dynes/cm^2, more particularly less than 10^5 dynes/cm^2. These figures are as measured at 21° C. (70° F.) ±3° C. using a parallel plate rheometric test at a frequency of 1 Hz.

The precise material chosen as the gel will depend on the application, and it may be used in a wide variety of applications particularly where deformation into intimate contact with a substrate, often of awkward or unpredictable shape, is necessary for sealing or other purposes, and where clean re-entry is likely to be required. Where environmental sealing is required, moisture resistance will generally be desired, and resistance to fungal or other degradation will be useful. The gel should be compatible with the materials of the article and substrate, and may have surface tackiness to hold it in place during installation.

Electrical insulation may be required, in which case the gel preferably has a resistivity of at least 10^8 ohm cm, more preferably at least 10^{10} ohm cm and for high voltage applications preferably at least 10^{12} ohm cm and a dielectric constant of from 2-6.

Where high temperature performance is required, for example in connection with high voltage cables, a material of the following type may be preferred. This material is referred to herein as a gelloid composition since, although it will in general have the appearance associated with the gels referred to above, it may have (although it preferably does not) cone penetration values or elongation values outside the above ranges, and may have a low gel fraction such as less than 15%. Gelloid compositions may comprise a cross-linked non-silicone polymer having an olefinic unsaturated content of less than 10 mole per cent and having 0.1-3 cross-links per weight average molecule; a liquid dispersed in the polymer in an amount of from 20-95% based on the weight of the dispersed liquid and the polymer; and a filler dispersed in the polymer and/or liquid at a volume fraction V of from 0-0.3 based on the polymer, liquid and filler, the composition preferably having a storage modulus of $(1 + 2.5\ v + 14.1\ v^2)X$ dynes/cm^2 where X is less than 5×10^5 at 30° C. and greater than 5×10^3 at 90° C.; the composition preferably having a dynamic viscosity of $(1 + 2.5\ v + 14.1\ v^2)Y$ poise where Y is less than 1×10^8 at 30° C. and greater than 3×10^3 at 90° C., and the composition preferably exhibiting first degree blocking.

In some instances, a degree of electrical conductivity may be desirable, for instance to fill voids around electrical components such as crimps used to connect high voltage electric cables, and stress-grading materials may be used to prevent electrical discharge. Thus a gel may be used that has a DC resistivity of from 10^3 to 10^{11}, preferably from 10^{10} to 10^{11} ohm.cm and a specific impedance of from 10^7 to 10^{10} ohm.cm at 60 Hz.

Conductive gels may also be used, suitable resistivities being less than 10^4 ohm.cm, preferably less than 100 ohm.cm.

Suitable gels may for example be made by gelling curable polyurethane precursor materials in the presence of substantial quantities of a mineral oil, a vegetable oil, or a plasticizer or two or more of these materials. Suitable quantities are 60-80% in the case of oil (particularly of a 1:2-5 mixture by weight of mineral oil to vegetable oil), and 30-70% in the case of a plasticizer such as trimellitate.

Gels may also be made by curing reactive silicones with non-reactive extender silicones.

The liquid polymer preferably comprises a butyl rubber, an epichlorohydrin rubber, an ethylene-propylene-diene monomer rubber, a hydrogenated styrene-butadiene rubber, a nitrile rubber or a functionalized polyisobutylene. The dispersed liquid preferably comprises a paraffinic oil, naphthenate oil, aromatic oil, liquid polybutene, alkyl or aryl phthalate, vegetable oil, mineral oil, trimellitate, ester of a polyethylene glycol, alkyl or aryl phosphate, methyl ester of hydrogenated wood rosin, liquid rosin oils, pine fat, polyterpenes, non-reacting liquid rubbers, etc. The filler may for example comprise any solid additive including particulate or fibrous matter and may function as to aid thermal or electrical conduction, for example for stress-grading purposes. Examples include carbon black, barium titanate, zinc oxide, iron oxide, silicon carbide, metals and the like, reinforcing agents, thermal stabilizers, fungicides, biocides, flame-retardents, for example aluminium trihydrate and halogenated flame-retardents, leak indicators, corrosion inhibitors, ultra-violet light stabilizers, processing aids, and impact modifiers. These additives may also be used with any of the other materials discussed herein.

A gel may be provided in the form of a tape, for example impregnated into an open-cell foam or other perforate backing layer.

We will now describe in general terms some preferred embodiments of the invention. In each case a sealing material may be applied to the substrate and/or to the article and an article comprising a double wall then revolved over the substrate. It may be thus applied in the field or the article may be supplied having the sealing material as a part thereof.

In a first embodiment, the article is used over a low voltage cable (including power and telecommunications cables), say less than 1 kV, or over an optical fibre cable, to provide environmental protection or electrical insulation to a splice in the cable or to act as a repair to

a damaged portion of the cable jacket. The double-walled tube preferably comprises an insulating material of resistivity greater than 10^{10} ohm.cm especially greater than 10^{12} ohm.cm, which preferably has an ultimate elongation of at least 150%, more preferably at least 200%, most preferably at least 500%, especially at least 900%. The material preferably has a dielectric constant of from 2 to 6. Water absorption into the material should be low, preferably less than 2% especially less than 1% by weight. The material and the friction-reducing means should be stable at temperature at least up to 90° C. for long periods of time. Tension set should be low. The material preferably has U.V. stability, as may be achieved by the addition of carbon black, especially when the article is for outdoor use. The article may be used in conjunction with a sealing material as mentioned above. Other uses for such an article include bus bars, bushings, fuses, elbow connectors and various other electrical connections, electrical wires, pipes and pipe lines, including hose and irrigation pipes, particularly over weld areas and damaged sections, pylons of off-shore oil rigs, flag poles, and other articles of circular or other cross-sectional shapes. It may be desirable that the article can be removed easily. The article may be used with additional means such as a casing for example an outer tube or half-shells for further mechanical protection. Preferably, the article itself or the article with the additional means will pass an impact test substantially undamaged that consists in dropping vertically onto the article a 5 cm diameter steel ball from a height of 40 cms, preferably 60 cms, more preferably 90 cms. Where the substrate is large relative to the article it may be desirable to use means to aid the initial revolving action as the article is first expanded over the end of the substrate. Such means may include a funnel or other generally conical or frusto-conical object which may be placed at the end of the substrate over which the article can gradually ride. Revolving action may also be aided by ears or legs affixed to the outer wall.

Where a cable comprises more than one conductor, for example the three conductors of a three-phase power supply, more than one double-walled tube may be used. In the case of the three-phase supply, a double-walled tube could be installed around each of the three cores, and optionally a further, larger, double-walled tube could be installed around the three covered cores.

In a second embodiment, the article may be used over a high voltage cable (splice or termination) or other conductor, generally greater than 1 kV, especially greater than 5 kV, often greater than 11 kV. Hence the article may provide, or be used in conjunction with, one or more other materials that provide, at least one or more of the following a stress-grading layer adjacent the conductor and the cable shield, and intermediate insulating layer, and an outer conductive layer providing shield continuity. A material suitable for providing stress grading preferably has a specific resistance of 10^7 to 10^{10} ohm cm, especially 5×10^8 to 5×10^9 ohm cm at 60 Hz and a D.C. resistance of 10^{10} to 10^{11} ohm cm. A material suitable as a conductive layer in such applications preferably has a resistivity of less than 10^4, especially less than 100 ohm cm. Each such material preferably, together with friction-reducing or separating means within its double wall as appropriate, preferably has an electrical strength of at least 100kV, especially at least 150kV per cm. Where two or more of these layers are provided by the article itself (the separation or friction-reducing means, particularly if it cures, may provide a layer) it will in general be necessary to cut the outer wall and roll it back down onto the substrate unless the inner and outer walls have the different electrical properties required. Preferred electrical properties were given above. We prefer that the inner layer comprise a void-filling stress-grading sealing material, and that a first insulation article be revolved over that material, and a second conductive article generally longer than the first be revolved over the first. The second article may in this way provide shield continuity across a splice. Alternatively, or additionally, a separate conductor, for example in wire or braid form, may provide shield continuity. A high voltage termination may also be constructed using one or more articles of the invention to provide one or both of a non-tracking layer and a stress-grading layer. The non-tracking layer should have suitable performance under the liquid-contaminant, inclined plane test, ASTM D2303. The material is desirably non-tracking and erosion resistant. Silicone materials and EPDM rubbers are preferred.

In a third embodiment cable protection, such as splice covering, cable jacket repair and termination, is provided in a dangerous or rough environment such as a mine. Here the double-walled tube preferably comprises a flame-retarded, abrasion-resistance and split or tear resistant material. Tear resistance, as measured by ASTM D624, Die C is preferably at least 90 N per cm (40 lb. per linear inch) especially 150 N per cm. The tube is preferably used with a sealing material such as a gel or a mastic that does not require heat for installation. In order to prevent the article revolving due for example to the cable being dragged along the ground, it may be particularly preferred to cut at least the outer wall and roll it back down onto the substrate. If the cut is made near one end of the article, both walls may be cut through since only a small length of the article will be lost.

Fourthly, an end cap, particularly a cable end cap or pipe plug may be provided. In this case the double-walled tube may be used in conjunction with an object that is in itself essentially an end cap, the tube serving merely to hold it in place. Alternatively, the tube may hold a blocking means in abutting relationship with an end of the cable or pipe. The blocking means may be provided fixed to a part of the inner wall of the double-walled tube.

In a fifth embodiment environmental protection is provided over a telecommunications cable splice. Such cables may contain up to, say, 2400 pairs of conductors, and splices can be considerably larger in diameter than the cables themselves due to the large number of crimp or other connectors required. The double-walled tube may be installed with ease over such a transition and can accommodate the changes in size, which it must do if it is to extend from the intact cable jacket of one cable across the splice region to the intact cable jacket of the other cable. It may be desirable to use the double-walled tube in conjunction with a liner which may be positioned over the splice and over which the tube is revolved. The liner may serve to provide mechanical strength, for example axial pull strength across the splice and impact strength, and especially if it has a metal component it may act as a moisture vapour barrier. If the separation or friction-reducing means is able to cure to a substantially rigid form after installation of the tube, it may be preferred to dispense with the liner. A preferred design of liner is a sheet of material that may be rolled around the splice (optionally being se-

cured in the rolled configuration by an adhesive tape) and having crowned ends, the tapered fingers of which being bendable inwards to provide tapered ends to the now rolled liner corresponding to the transitions from the larger splice bundle down to the smaller cables. Instead of being in sheet form the liner may comprise two or more generally rigid half-shells.

It is often desirable to provide an environmental seal around a branched cable splice, where the branching cable leaves the splice almost parallel or at a small angle to to another of the cables, i.e. in a generally Y formation. Such a splice may be sealed by installing some sort of cover around it, but a problem arises in sealing the crutch region between the branching cables. Examples include branched telecommunication cables splices, or low voltage power branch joints, for example for street lighting. A seal can be made using the present invention by revolving a double-walled tube to a position overlying the splice such that it spans the region to be sealed. Where three cables are spliced in a generally Y formation, it will be convenient to revolve the tube, previously positioned at a place remote from the splice, along the cables represented by the base of the Y until it overlies the splice, although it could be revolved along both of the others. In some embodiments, the crutch region may automatically become at least partially sealed by virtue of the inner wall of the tube becoming deformed inwardly to conform to the shape of the cables. This effect will be greater, the greater the filling volume within the double-walled tube and the consequential greater tension in the outer wall since the inner wall must be expanded in order to conform to the cables.

Alternatively, or in addition, a sealing material may be provided in the crutch region, preferably a sealing material that is sufficiently soft that it can be deformed by the double-walled tube as it is revolved into position. A dam, for example a sealing material of greater stiffness than the sealing material proper, may be provided to restrict its flow or its deformation. Preferred sealing materials comprise mastics, curable adhesives and gels as described above. The sealing material may initially have the form of a block such as a rod or bar of such a cross-section, for example having concave opposite sides, that it conforms in generally to the shape of the crutch region. It preferably however extends proud of the cables so that it can be deformed as the tube revolves over it. Where the sealing material is of low viscosity it may be temporarily held in a container, preferably of the shape described. It may be noted that the revolving action puts the sealing material under compression but does not tend to displace it longitudinally. The tube may therefore be advanced so that the sealing material is completely covered.

The branch-off technique disclosed above allow seals to be formed that may be preferred for temporary closures, aerial splice closures or for non-pressurized cables. However, for long term closures for pressurized cables a stronger seal may be preferred. Such a stronger seal could be formed by employing an adhesive, such as a curable adhesive instead of or in addition to a mastic or a gel. Such an adhesive could be used in the way suggested above. Alternatively, an adhesive, or other sealing material could be provided within the double wall, optionally serving also as the separation or friction-reducing means, and released for example by puncturing the inner wall allowing the sealing material to flow into the crutch region and form a seal.

Any of the above seals may be enhanced by the use of means which bring towards one another the inner and outer (or just the inner) walls between the branching cables. A branch-off clip, such as that disclosed in Great Britain No. 2,019,120 may be used. Where a three legged clip is used, the centre leg may comprise a sealing material as mentioned above.

In a further embodiment, the invention provides a mechanical, and preferably leak-proof, coupling between two elongate substrates such as pipes. Here the requirement is axial pull strength, and optionally fluid tightness, rather than environmental protection of the surface of the substrate although that too may be provided. We prefer that the double-walled tube be used in conjunction with a substrate of such size that its inner wall where installed is under a tensile strain of at least 0.02. The article can provide at least three significant advantages as a pipe joint. Firstly a leak-proof joint can be made that will retain significant pressure. Secondly, the joint may be made or broken very quickly, and without tools. The article is simply revolved along one pipe generally by hand, that pipe and the pipe to which it is to be joined are placed end to end, and the article revolved to a position where it bridges the ends. The seal may be reinforced, with sealing materials as described above, or with an H-seal or other mechanical seal. Where the substrates to be joined are easily compressed, a support may be provided either around their outer surfaces so that the double-walled tube engages them at a position a short distance from their ends, or it may be provided as an internal support. Such a support may comprise a rigid tube or half-shells or a braided tube may be provided because of its flexibility.

A third advantage of the article for use as a pipe coupler is that it can combine an excellent fluid tight seal with flexibility, particularly allowing slight bending between the substrates joined. Also, the joint can absorb vibrations in one substrate, preventing or reducing their transmission to the other. The article can serve to transmit rotational motion.

The article is particularly useful as a pipe joint for water hoses, particularly for larger scale irrigation as well as gas and oil pipes, etc. Where a highly flexible pipe is to be joined, a substantially rigid internal support may be used.

In a seventh embodiment the article may be used to deliver an object onto, or move an object along a substrate. In general, the object, will have an opening therein of smaller diameter than that of the substrate and be deformable, particularly elastically deformable, such that it has to be stretched in order to fit on the substrate. Use of the article as a delivery system will, however, be useful even where no deformation of the object is required or possible (for example in the case of a ceramic high voltage shed); the article may then act as a spacer or gasket between the object and the substrate.

Installation may be carried out as follows. An end of the article is positioned on an end of the substrate in the usual way, i.e. by a revolving action, and then at least a portion of the object is positioned on the article. A force is then applied to cause the article to revolve. The force may be applied between the outer wall of the article and the substrate, or directly between the object and the substrate. This force causes the article to revolve and the object to be carried onto the substrate. Initially, the article will be positioned between the substrate and the object, and in this configuration the object may be moved along the substrate by revolving action of the

article a distance generally equal to the length of the article. In some embodiments, particularly where the object is flexible, it may be deposited directly onto the substrate by continuing the revolving action such that the object is turned outside-in. A sealing material may thus be applied to what is initially an exterior surface of the object to provide a seal between the object and the substrate. The article may be removed by continuing the revolving action further or by reversing it back across the now installed object.

Where the article is used to apply sheds to a high voltage termination, it may be desirable that the article have stress-grading properties and be left in place between the cable and the shed. In such an instance the lubrication system may be hardenable particularly if later removal of the shed is not envisaged.

The article may be used to deliver an object to a specific position along a substrate. Here it is generally necessary to do one of three things. Firstly one may revolve the article onto an end of the substrate a certain distance before the object is placed over the free end of the article. Secondly one may place the object a certain distance over the article (for example by collapsing the article) before the article is revolved along the substrate. Thirdly, one may choose the length of the article such that the revolving action may start with the object at its end. In order to carry out the first two techniques effectively, the article may be provided with markings on its surface that can be correlated to the distance from the end of the substrate to which the object will be delivered.

An object positioned on a substrate may be removed or re-positioned using the article by a similar technique. If removal is to be prevented, the article may be provided with means that prevents axial movement in one direction. For example it may be provided with interior protuberances, such as barbs, that limit axial motion. The object may thus be installed on the substrate from one end thereof, but prevented from being removed from that end by the article.

In an eighth embodiment an article comprising the double walled tube is part of a larger device, and in particular comprises an outlet for an enclosure through which a substrate may pass. For example, the enclosure may house a cable splice and may comprise a CATV (cable antenna television) splitter box or a optical fibre splice case having therein one or more optical fibre organizers. An outlet for such a housing may consist of the double-walled tube, fixed for example in a hole in a wall, or it may comprise a rigid tubular outlet to which the double-walled article is attached. A cable or other substrate may simply be pushed through the double-walled tube the desired distance (the maximum distance will depend on the length of the double-walled tube and the way in which it is affixed to the enclosure) and a connection made to another cable or whatever inside the enclosure. The double-walled article will thus form an environmental seal around the cable, isolating the interior of the enclosure from the outside.

A ninth embodiment comprises a duct seal. Whilst a duct seal of sorts is provided in the previous embodiment (between the cable and the hole in the wall of the enclosure through which it passes) it is only brought about by the movement of the cable into the enclosure, and that movement will in general be limited; a modification will be preferred if a duct seal is to be provided between a substrate and a duct that are fixed relative to each other. This can be achieved by an article comprising two (or more) mutually substantially concentric double-walled tubes. Relative sliding motion between a substrate and a first double-walled tube may be avoided by sliding motion between the two walls of that tube, and that of course was all that was needed when the article was simply to be installed over a substrate. In the case of a duct seal, however, sliding motion between the seal and the duct has to be considered in addition to sliding motion between the seal and the substrate. The second double-walled tube, positioned around the first, takes care of that. Thus a double revolving action can take place by providing an axial force between the duct and the substrate on the one hand, and the outer wall of the inner article and the inner wall of the outer article on the other hand. This axial force may be applied by pushing or pulling on a tube or one or more rods or cords or other means that engages the outer and inner walls referred to. As in other embodiments, a sealing material may be used in conjunction with the article to enhance sealing. Means may also be provided to prevent further revolving action once the double article has been properly positioned in the duct. Such means may be particularly desirable where a pressure difference across the seal is expected.

Harnessing is provided by a tenth embodiment of the invention. Bundles of wires may be held together by revolving over them one or more double-walled tubes. Harnesses of considerable length may be made in this way, since the problem of friction in sliding a long tube over a long substrate is avoided. The existence of branches in the harness does not provide a problem: separate double-walled tubes may be provided over the branches, and the main trunk between the branches can be covered by revolving a double-walled tube over both the trunk and branch until it passes the branch and then back again to the desired position. In addition to producing cable harnesses, the double-walled tube may be used over two or more other substrates to hold them together mechanically.

An eleventh embodiment provides a cable block. Here the separation or friction-reducing means contained within the double wall is released and delivered to a desired region, for example the core of a multi-conductor cable where it may then cure or otherwise harden. Thus a cable block may be formed by revolving the article along a cable to a region such as a splice where the cable jacket is absent. When in position the inner wall of the double-walled tube is punctured and the tension in the outer wall causes the previously trapped material to be displaced into the cable. If the rate of release of the material is sufficiently slow, the puncture may be made while the double-walled tube is to one side of its desired position, since in this case it is the more accessible outer wall that is to be punctured. The tube is then moved to the desired position. The article may of course be used to deliver its contents for purposes other than the formation of a cable block. Displacement of the material may occur automatically due to the tension in the outer wall, or it may be caused or aided manually, by tape wrapping or by inflation or other means. It may be noted that puncturing of the inner wall results in the article having what may be regarded as an inside-out configuration. As a result the wall of the article is not subjected to peel by an internal pressure, as may result from the article being installed over a splice in a pressurized cable. This feature may be more relevant when a cable block is not provided since the block itself should prevent pressure from acting on

the article. The reason that the article is not in peril is that internal pressure acts through the puncture on the inside of the article, thus forcing the inner wall against the substrate. For this effect to be achieved the material of the article must have a certain strength, or inflation of the article at its ends must otherwise be prevented.

In a twelfth embodiment environmental protection, thermal insulation or leak repair is provided around a pipe or a pipe joint. Where thermal insulation is required, such as around a joint in a district heating pipe, it may be desirable that a thermal insulation such as a gas or a foam or foamable liquid is provided in the closed region.

As will be apparent, this invention is extremely versatile. Situations or details where the invention can be substituted for a prior art article or technique can be found in the following: U.S. Pat. Nos. 3,610,291 to Hesbop, 3,950,604 to Penneck, 4,118,260 to Boettcher, 4,142,592 to Brusselmann, 4,154,082 to Campbell, 4,350,842 to Nolf, 4,400,579 to Nolf, 4,409,426 to Nolf, 4,426,413 to Fentress, 4,431,861 to Clabburn et al, 4,466,843 to Shimizak, 4,467,137 to Paget et al, 4,485,269 to Steinberg, 4,478,486 to Fentress, 4,498,732 to Fentress, 4,499,129 to Krdil, 4,511,611 to Moisson and 4,518,819 to Larsson et al, and Great Britain 2,110,479 to Link et al, and 2,125,637 to Clabburn et al.

This invention is further illustrated with reference to the accompanying drawings, in which:

FIG. 1*a* is a perspective view of a typical article of the invention;

FIG. 1*b* is a transverse cross-sectional view of the article;

FIG. 1*c* is an axial cross-sectional view of the article;

FIG. 2 illustrates a preferred method of forming the article;

FIG. 3*a* illustrates an initial revolving action;

FIG. 3*b* illustrates subsequent revolving action;

FIG. 3*c* illustrates the installed article;

FIG. 4 illustrates the use of a cone-shaped device to expand an article of the invention just prior to its installation over an elongate substrate;

FIG. 5 illustrates an axial cross-section of a low voltage cable joint enclosed by an article of the invention;

FIGS. 6*a*–*d* illustrate the use of an article of this invention as a protective cover over an end of an elongate substrate;

FIG. 7 illustrates the use of an article of this invention together with a sealing material to protect a cable breakout;

FIG. 8 illustrates a joint between high-voltage cables protected by a conductive and insulating article of this invention;

FIGS. 9*a* and 9*b* illustrate a dual conductive insulating walled article of this invention;

FIG. 10 shows an article of this invention further comprising sheds for application to a high voltage termination;

FIG. 11 illustrates the use of an article of this invention as a duct seal;

FIG. 12 illustrates the use of this invention for sealing a telecommunications cable splice;

FIG. 13 illustrates the use of the present invention for joining together two pipes;

FIG. 14 illustrates the double-walled tube as part of a larger device;

FIG. 15 illustrates the use of the articles of the invention in forming a cable harness; and

FIGS. 16–19 show an article of this invention being used to install an object onto a substrate.

In each of the applications illustrated, a sealing material may be applied to the substrate and/or to the article and the article then revolved over the substrate. The figures illustrate the various articles and substrates, but in some instances a sealing material has been omitted for clarity

A typical article is illustrated in FIGS. 1*a*, 1*b* and 1*c* which provide respectively perspective, transverse cross-sectional and longitudinal cross-sectional views. The article 1 comprises an outer wall 2 and an inner wall 3. The walls are joined to form a continuous, closed double-walled tubular structure. A friction-reducing means 4 is located within the double wall, separating the walls and allowing relative sliding motion between them.

The wall sections may comprise a plurality of layers of material formed for example by lamination or co-extrusion. For example, the inner and outer walls may each comprise an interior layer (i.e. a layer facing the closed area within the double-wall structure) of say butyl rubber which is an effective gas diffusion barrier, and an exterior layer of ethylene-propylene-diene terpolymer rubber which has excellent weathering properties.

A separation means 4 may be provided between the inner and outer walls Such separation means may be solid, liquid, or gaseous. Examples of gases include air, oxygen, carbon dioxide, nitrogen, acetylene, helium, etc. The gas is preferably under a gauge pressure such as from 0.07 to 1.4 Kg per square cm (1–20 p.s.i.g.), more preferably 0.07 to 0.7, most preferably 0.14 to 0.35 Kg per square cm. Furthermore, the gas may be selected for its chemical, physical or electrical properties etc., for example an insulating, electronegative gas such as sulphur hexafluoride may be selected for use in a high voltage environment. The gas may be formed in situ from solid and/or liquid components within the double-wall, or it may be introduced from outside through a valve etc. For example, carbon dioxide may be generated in situ from a mixture of acetic acid and sodium bicarbonate. These components may be initially separated by a barrier such as polyethylene film until the article is to be installed. Then breaking of the barrier permits the components to react and generate the gas within the double wall. Similarly, acetylene may be generated in situ from calcium carbide and water.

When the separation means comprises a gas, the tubular article should be capable of inward expansion when the pressure of the gas is increased.

An article of this invention, generally tubular in shape, can be made by a variety of methods. The manner in which it is made is generally not critical. A preferred method of manufacture is illustrated in FIG. 2 in this method, a tube 5 approximately double the desired length of the tubular article is formed by, for example, extrusion. The ends 6 and 7 of the tube 5 are folded over until they form an overlap region as illustrated. Solid, liquid or semi-solid friction reducing means can be added at this point. The ends 6 and 7 may be secured together, for example by means of an adhesive, forming the continuous wall of the double-wall structure. The adhesive used should form a sufficiently strong bond to keep the ends 6 and 7 together during installation and use of the article. The adhesive can be for example a hot melt adhesive, pressure sensitive adhesive, curable adhesive e.g. of the same elastomer as the walls, contact

adhesive or the like. If a solid friction-reducing means such as poly-tetrafluoroethylene, (PTFE) is used, a layer of PTFE may be laminated or bonded to the outer surface of the initial tube 5 before the ends 6 and 7 are folded back. If a grease is used, it may be spread onto the outer surface tube 5 before ends 6 and 7 are folded back.

Another preferred method comprises extruding individual tubes, one of smaller diameter than the other, arranging the tubes in concentric relationship and then bonding the ends of the tubes together The friction reducing means, if solid, can be advantageously applied to the outer surface of the tube of smaller diameter. Gaseous or other separation means, and liquid and particulate or powdered friction reducing means can be inserted between the concentrically arranged tubes prior to sealing both ends thereof. The friction reducing means can also be added into the space between the walls by injecting the appropriate material through a relatively small opening in the wall and then sealing the opening. The walls can be provided with a one way valve, preferably one that is relatively flat, to facilitate injecting the friction reducing or separation means into the space between the closed, double-walls. This is particularly advantageous if a gaseous separation means is used.

The tubular article can be formed by any other method, for example molding, casting, or the like. The walls of the article can be formed by dip coating a solid cylindrical object comprising a material which on subsequent treatment, e.g. crushing, dissolving, melting or the like, forms the friction reducing means.

The walls may be joined together by any technique suitable for the particular material of which they are made. Such techniques include, for example, adhesive bonding, for example by hot-melt adhesives, fusion bonding, ultrasonic welding, vulcanizing, clamping, taping or the like. Joining of the walls may include the use of an additional segment of flexible material, if desired, for example to reinforce the join area, e.g. by use of a patch or strip of flexible material. Preferably the walls are directly joined together using a lap, butt, scarf joint or the like.

To apply the double-walled tubular article 1 to a substrate 8, an end 9 of the article is expanded to the outer diameter of the substrate and an end of the substrate is inserted into the expanded open end 9 of the article, as shown in FIGS. 3a and 3b. The end of the article can be expanded manually if the difference between the inner diameter of the article and the outer diameter of the substrate is not too great and/or if the flexible material of the article is easily stretched, that is has a relatively low durometer hardness. (Installation over a cylindrical substrate with a flat end surface may be found easier if the tube is first positioned assymetrically with respect to the substrate, i.e. such that an edge (rather than the flat end surface) thereof extends slightly within the inner wall of the tube. The revolving action is then started, initially to cause the tube to move across the flat end surface. This should result in the end of the substrate lying wholly within the tube. Revolving action now can be continued in the usual way.) The force on the article will generally be applied at line 10, i.e. close to the end 9 of the substrate. The article defined above would buckle if it were applied at position 11. From FIG. 3b it can be seen that the circumferential tension in the right hand end 9 of the outer wall 2 will be greater than in the left hand end which would cause the friction reducing means 4 to be driven away from where it is needed, were it not for some means to restrict such displacement. Where there is a significant difference in the dimensions of the article and the substrate, e.g. up to about 5× or even greater, the article can be expanded over, for example a cone-shaped mandrel. e.g. a funnel described further below. If desired, the article can be positioned and then stored on a mandrel or support of greater diameter than the article The pre-expanded article can then be applied to a substrate by applying an axial force to the outer wall of the article causing it to move from the mandrel to the substrate with the unique revolving action. In this embodiment a relatively small initial force may be all that is necessary as the expanded article tends to self-revolve onto the smaller substrate.

Continued axial force causes the tubular article to move axially along the substrate as shown in FIG. 3c until the desired position is reached. If the axial force is discontinued, the tubular article remains where it is positioned on the substrate. If axial force is again applied to the outer wall generally in either direction the article will move along the substrate. Thus, the article can be used to cover, for example a cable joint. Before the cables are joined, the tubular article is positioned over one of the cables and axially revolved away from the cable end The cables are then joined and the tubular article is positioned over the joint by applying an opposite axial force relative to the outer wall.

FIG. 3c illustrates, partially in cross-section, article 1 when fully on an elongate substrate. Article 1 comprises outer wall 2, inner wall 3 and friction reducing means 4 In FIG. 3c the arrows indicate movement of the outer wall 2 while substrate 8 substantially prevents axial motion of inner wall 3. As a result outer wall 2 progressively revolves into contact with the surface of substrate 8 resulting in moving the article 1 in an axial direction from left to right in the drawing.

FIG. 4 illustrates the use of a device 12 to expand double-wall tubular article 1 as it is about to be applied to substrate 8. Article 1 has an initial internal diameter which is less than the outer diameter of the substrate 8 to which it is to be applied. Device 12, conical in shape, is used to expand article 1 so that its inner diameter is substantially equal to (optionally could be expanded to greater than) the outer diameter of substrate 8. Axial force on outer wall combined with frictional and compressive force between inner wall and device 12 causes the article 1 to revolve in the direction of the force and it progressively advances along the cone-shape of device 12 thereby expanding. Continued axial force in that direction will cause article 1 to revolve onto substrate 8 and along substrate 8 until that portion of the substrate to be covered or enclosed by article 1 is reached.

A sealant, or gel or an adhesive may be applied to either the substrate or the article and in that case it may be particularly desirable to clean the surface of the substrate first. This may be done using cleaning means such as an abrasive strip or a cleaning tissue containing a suitable solvent. Because of the revolving action of the article, the outer surface can be so coated and on installation that surface revolves down onto the outer surface of the substrate. As discussed in more detail below, the surface of the article can be coated with other materials, e.g. conductive paints, etc., stress grading materials, corrosion resistant materials, heat activatable adhesive, or the like. This overcomes a major disadvantage of many prior art articles which require coating the inner

surface of a tubular article to be, e.g. heat recovered, over a substrate and bonded thereto by the inner layer of adhesive

Another technique for prevening further movement of the article along the substrate is to make the wall section to be adjacent the substrate substantially thicker than the other wall section. Once the thick wall section has been brought into contact with the substrate due to the axial revolution of the article, the thickness of the wall tends to inhibit or prevent further axial motion. Yet another technique is to revolve the article axially into the desired position and then remove the friction reducing means from within the double-wall of the article. This causes inner and outer wall sections to come into contact which generally makes further axial movement of the article difficult. This is especially convenient when a separation means comprising a gas is used, when the wall sections are both elastomeric and the substrate has a larger diameter than the initial inner diameter of the tubular article. The gas can be readily removed by puncturing the continuous double-wall of the tubular article. The stretched elastomeric material of the inner and outer wall sections exerts an inward force between the inner and outer wall sections and between the walls and the substrate. The resulting frictional and compressive forces between the elastomeric walls and the substrate, makes removal of the tube by application of an axial force extremely difficult if not impossible.

Such an article may, if desired, be provided with a valve, preferably one which is relatively flush with the wall that carries it. The valve may be used to remove a gaseous separation means as above. Then if, at some later time, it is desired to remove the article from the substrate, a fluid may be introduced into the region between the walls through the valve, allowing the article to be moved along the substrate as desired. The fluid may be removed or introduced by use of a syringe.

Removal of a gas or liquid may occur through the walls of the tubular article permeable to that gas or liquid. For example, the walls may be made of fluid permeable silicone rubber or neoprene rubber, through which the liquid or gas may pass. To prevent premature loss, the gas or liquid may be packaged in the annular space in a barrierable container such as a flexible bag made of aluminum. Alternatively, the entire article may be enclosed in a fluid impermeable container such as an aluminum bag, a metal can, or a pouch of the type used for liquid beverages. When the article is to be positioned on the substrates, it is removed from the container, and revolved into position The gas or liquid then passes through the permeable walls of the article restricting further revolving.

The article may be applied to a variety of substrates, the size of the article being selected to accommodate the desired substrate. Articles having elastomeric walls can accommodate substrates of different dimensions. Further, an article may be used to enclose an elongate substrate whose diameter varies along its length. For example, the article may be positioned over a relatively large diameter splice bundle and the adjacent relatively small diameter cables, forming a tight fit with all underlying regions of the substrate. The axial revolving motion of the article permits it to be applied over relatively sharp changes in substrate diameter as well as tapered or gradual changes in diameter. We have suprisingly found that the article is able to ride up sharp changes in diameter, for example 90° transitions by collapsing concertina-like at its end and thus forming its own funnel as a series of steps up to the larger diameter. Substrates enclosed or covered by the article may be cylindrical but can be of any cross-sectional configuration.

FIG. 5 illustrates the use of the article to cover a low voltage (i.e. below about 1000 volts) cable joint. As illustrated, the outer layers 13 of insulation and protection of the cables 14 have been removed to expose bare conductors 15. These conductors are connected by connector 16. Sealing material 17 in the form of a tape is applied around each cable insulation 13. The sealing material may comprise an elastomer-based composition such as that disclosed in U.S. Pat. No. 4,497,926 to Toy or a sealant tape such as that disclosed in GB 2,123,026 or EP 174,165. Article 1 has been positioned over the joint. Article 1 may comprise for example a continuous double-walled structure of neoprene 1.5 mm (60 mil) thick with a silicone oil 4 within the double-wall, or an EPDM rubber of wall thickness about 90 mm and a friction-reducing means comprising a propylene glycol and polyacrylamide. Article 1 provides insulation for the conductive elements as well as mechanical protection, and together with sealant sealing material 17 environmentally seals the joint.

Sealant tapes of this type permit the article of this invention to be readily removed when desired and reinstalled reforming a seal between the article and the cable. Another method of retaining the article in the cable is to remove the friction-reducing means from between the double walls.

For some uses of the article of this invention, such as its use over an electrical cable joint, it can be important that moisture, including moisture vapor, be excluded from the joint area. It is known that moisture vapor can diffuse through polymeric articles. Moisture vapor transmission through the article of this invention can be prevented or at least minimized by placing a metal foil layer between the inner and outer wall sections. The foil can be laminated or applied by vapour deposition to one or both of the interior surfaces within the double-wall if desired. Another method of introducing a metal layer is to place a quantity of low melting metal alloy into the space within the double-walls. Just before installation, the article is heated, for example by immersion in hot water. This causes the low melting alloy to melt becoming a liquid which can function as a friction reducing means. The article is then installed over the joint and allowed to cool. The metal alloy will solidify forming a metal layer within the double-wall structure which can function as a moisture vapor transmission barrier.

FIGS. 6a–d show a double-walled article 1 used to enclose an end of an elongate substrate 8, such as a cable. The article may be positioned so that a portion thereof extends over the substrate and a remaining portion extends therefrom The extending region may be clamped or otherwise closed to seal the opening therein. Another method of sealing the end of a substrate is first to place a piece of protective material over its end and then apply the article over the protective material and substrate end. The article then holds the protective material in place. An alternative is illustrated in FIGS. 6a and 6b where the article 1 is used to hold a truncated cone 18 or other end block against an end of a cable or other substrate 8. FIG. 6a shows the situation before installation, and FIG. 6b after. A sealing material 17, for example in the form of a tape, may be used to retain the article in the installed position and/or to enhance an environmental seal. The article may also be retained by removing its friction-reducing means. The end block 18,

may be pre-installed on the article 1. For a typical application, article 1 has inner and outer walls comprising a rubber such as neoprene, preferably 0.1 to 0.2, especially about 0.17 cm (0.062 inches) thick and 2 to 20 cm especially about 8 cm long. The double wall preferably contains 1.0 to 10 especially about 5 gms of a thickened aqueous solution of a water soluble polyacrylamide. The internal diameter of the article will depend on the size of the substrate, but from 0.2–20 cms is a useful range. We prefer that the article be readily removable from the end of the substrate, in which case we prefer that any sealing material 37 does not form a permanent bond.

FIGS. 6c and 6d show a closure comprising a tubular cover 19 having a closed end and an open end. The closure also includes a double-walled article 1 which is attached, for example by an adhesive, to the interior of the cover 19, proximate to its open end 21, thereby preventing the article being revolved off the cover 19. Alternative attachment means include mechanical devices such as a screw, bolt or retaining ring, or heat welding, or solvent welding The closure is shown being used to protect an end of a threaded pipe 22 by way of example. The cover 19 with article 1 may also be used as a closure for a container such as an ammunition canister. Ammunition canisters need to be inspected frequently and the excellent moisture seal combined with ease of re-entry obtainable by the invention is a great advantage. An indication that such a seal has been tampered with may be provided by a coating for example of a lacquer that will crack on re-entry.

A further use for such closures is over solid substrates such as table legs to prevent their damaging a floor etc. or to prevent sliding.

In FIG. 7, cable 14 has been broken out into cores 23. To protect the cable from ingress of water, pollutants in the environment, dirt, etc., at the cable breakout, a profile 24 of sealant or other sealing material is positioned at the breakout. Profile 24 may be preformed with three holes to accommodate cores 23 which pass therethrough. An article 1 is positioned around the profile 24 and the adjacent area of cable 14. The inner diameter of the double wall tubular article is less than the outer diameter of the profile 24. The resulting compressive force maintains the profile, which may comprise a gel or other conformable sealing material, in intimate contact, or causes it to come into intimate contact, with each of the cores to produce a leak-proof enclosure around the breakout.

The article can be used in enclosing a high voltage joint or similar electrical equipment, such as joints or terminations of electrical power cables Typically an enclosure for a high voltage joint comprises a plurality of elements to provide the desired electrical and mechanical protection. As mentioned above, a popular method of enclosing a high voltage joint is to apply one or more heat-recoverable sleeves. To provide the electrical properties required for a high voltage joint several layers of material having different electrical properties are employed either as a composite sleeve or as individual sleeves. A heat recoverable enclosure for high voltage joints is disclosed in U.S. Pat. No. 4,383,131 to Clabburn. One or more of the layers of such a joint may comprise the double-walled article.

For example, the outer conductive, or shielding layer, may be applied in the form of the article, in the form of a separate layer delivered by the article, or as a separate layer held in place by the article. The conductivity may be a property of the materials of the walls and/or of the separation or friction-reducing means. A resistivity less than about 5×10 ohm cm will generally be desirable. The walls alternatively may comprise a conductive polymeric (preferably elastomeric) material. They may also comprise a metallic mesh, screen or braid, for example embedded in the walls or laminated thereto. Conductive material may be present in the friction reducing means, for example as a thin metal layer deposited on the interior surfaces of the double-wall. A low melting alloy may also be used when molten as a friction reducing means and may solidify to provide shielding and/or act as a moisture-vapour barrier.

FIG. 8 illustrates a joint between high voltage electric cables 14, enclosed in a conductive and an insulating article.

In FIG. 8 are shown two 5 kV electric cables 14 with their outer jackets removed to expose shields 25, insulation and conductors 15, joined by conducting crimp or other connector 16 A void filling sealing material 26, preferably one that is stress grading, e.g. a polyepihalohydrin-based composition such as that disclosed in U.S. Pat. No. 4,378,463 to Senior et al. is placed over the conductors and insulation. An insulating article, 27, is positioned across the joint. The separation or friction-reducing means between the double-wall of article 27 is a relatively void-free material having suitable dielectric properties to insulate the joint. On top of insulating article 27 a further, but conductive, article 28 has been installed. The conductive article is shown connected to the cable shields by means such as leads 29. Alternatively or in addition the article 28 may extend past an end of article 27, thereby directly contacting a cable shield. Additional stress grading material may be desirable around conductors of higher voltage than 5 kV. This may be provided, if desired by use of a stress grading article of this invention.

While a high voltage joint may be produced using a double-walled article for each of the stress grading, insulating and conductive layers, it is to be understood that any of these layers may be provided in a conventional manner. Thus any one of the layers, two of the layers or all three layers may comprise or may be applied using the double-walled article.

The insulating and conductive layers of the joint enclosure can be provided in a single article. In this case the inner and outer walls may be of different materials, one being insulating and the other being conductive. The walls may be positioned with respect to each other such that when the article is applied to the joint, the conductive wall is outermost. Each wall may be a dual wall with an exterior insulating layer and an interior conductive layer. Application of such an article over a joint may require the additional step of creating a radial split in the outer wall as installed. This can be done, for example, by radially cutting through the outer wall, by removing a patch joining wall sections together, by dissolving the bond between the ends of the wall sections, etc. The resulting two wall ends are then slid along the inner wall and onto the substrate. The result is a single wall, having an interior insulating layer and an exterior conductive layer installed over the joint. This is illustrated in FIGS. 9a and 9b. In FIG. 9a, tubular article 1 has inner and outer walls each comprising an exterior insulating layer 30 and an interior conductive layer 31. The outer wall is radially slit through both layers and the resulting free ends are then slid as indicated by

the arrows, aided preferably by any friction-reducing means that remains. The slit may alternatively be made towards one end of the article in which case it may penetrate both the inner and outer walls. In general, shear (as described) or peel between the two walls may occur in the absence of the revolving action to cause each wall to be adjacent to the substrate.

A stress grading material, provided by the double-walled tube or otherwise, preferably comprises a material having specific impedance at 60 Hertz of about 10^7 to about 10^{10} ohm-cm. Typical stress grading materials include polymeric materials, preferably an inherently stress grading material such as polyepihalohydrin and epihalohydrin copolymers or a polymeric, in particular an elastomeric, material having dispersed therein conductive particles such as carbon black, silicon carbide, iron oxide, metal or mixtures thereof.

As described above for the outer conductive layer, the stress grading layer may be provided as a composite structure with the insulating layer. In this case, the stress grading layer may comprise the inner wall of the article (when installed) with the outer wall being insulating. A dual wall structure can also be used with the exterior layer being stress grading and the interior layer being insulating. In this embodiment, the outer wall is radially slit and the free ends (or end as appropriate) are slid along the article and into contact with the substrate. The stress grading layer will then be immediately adjacent the substrate with the insulating layer surrounding it. An outer conductive article can then be applied. The conductive article can be a conductive article in accordance with this invention, a conventional dimensionally recoverable article, tape, paint, metallic mesh or braid, or the like.

An article of this invention combining stress grading, insulating and conductive layers can be provided if desired. In this case a three layered wall is provided having an exterior stress grading layer around the entire article, an intermediate insulating layer, and an interior conductive layer. The article is installed over the joint and the outer triple wall section is radially slit and the free ends (or the end as appropriate) slid down onto the cable. This results in a sleeve over the joint comprising an innermost stress grading layer, an intermediate insulating layer and an outer conductive layer.

As will be readily apparent to one skilled in the art, the materials of the walls and friction-reducing means can be varied to provide the combination of electrical, mechanical, physical and chemical properties desired for a particular use. The above description merely illustrates some of the types of selections that can be made.

An additional example of the myriad of variations possible in construction and using the article of this invention is the use of the article to enclose a high voltage termination. High voltage terminations generally are not shielded as are high voltage joints. They are however provided with sheds which increase the length of the outer surface of the termination thus improving its resistance to flashover or electrical discharge.

At higher voltages, e.g. above about 5 kV, a stress grading layer is generally provided over the cable insulation and bridging the cable shield. As with high voltage joint enclosures as discussed above, the stress grading layer may be provided by use of a stress grading material in the walls or as the friction reducing means. The insulating material should be relatively void free and a non-ionizing material should be used for the friction-reducing and any separation means.

In enclosing a termination of this invention the stress grading layer, if present, is first positioned over the cable conductor and the lug or other device to which it is terminated. The stress grading layer may be provided by this invention. The insulating layer is then applied, and that too may be provided by this invention.

Sheds may then, if desired, be applied by any technique. Individual sheds may be slid over the end of the terminating lug into position on the installed article. The sheds are preferably of an elastomeric material and have a center hole slightly smaller in diameter than the diameter of the installed article. The sheds may be an integral part of the article comprising a double-walled tube, as shown in FIG. 10. In FIG. 10 an article 1 of this invention has outwardly projecting sheds 32 toward one end thereof. As the article is applied to the termination the sheds are carried, along with the wall to which they are attached, to their desired position.

The sheds 32 may be of sufficiently flexible material that they do not restrict or at least do not prevent the revolving action of the article. The sheds may comprise, if desired, the same material as that of the wall sections of the article. This may be done for example by providing radial bands of relatively stiff material interposed between segments of highly flexible material, and applying a force at each end of the article toward the middle to cause the walls to buckle, forming outwardly projecting sheds.

In enclosing a termination in accordance with this invention at least one of a stress grading layer, an insulation and a shed is applied utilizing a double-walled article.

FIG. 11 shows the provision of a duct seal 33 by means of the invention. What follows applies also to the provision of what is known in the cables accessories and other arts as a feedthrough; the articles have similar functions and they differ primarily in the greater length of a feedthrough. An annular space between a cable 14 or other supply line etc and a bulkhead or duct etc. 34 is to be sealed to prevent the transfer through it of moisture or other contaminant or heat etc. An article 33 comprising two mutually substantially concentric double-walled tubes 35 and 36 is positioned around the cable 14. The two tubes are then caused to revolve as indicated by the arrows. This may be achieved by inserting into the right hand side of article 3 as drawn (or withdrawing from the left hand side) some means 37 that engages the outer wall 38 of the tube 35 and the inner wall 39 of tube 36. It can be seen that the article 33 can advance to the left as drawn without shear between either it and the cable 14 or between it and the bulkhead 34. The means 37 may comprise a cylinder or a frame or one or more elongate devices such as rods or cords etc. Means 37 may be left in place when the article 3 has reached its desired position within the duct. Alternatively, means 37, particularly if it comprises rods or cords etc., may be removed, for example by pulling on means 37 whilst holding article 3 against further revolving action. Where a pressure difference across the bulkhead is expected, means may be provided to prevent the revolving action once the article has been properly positioned. Such means may include positioning of a block on at least one side of the installed article 3, such as a hose clamp 40. Further revolving action may also be prevented by the friction-reducing means or a separation means 4 solidifying after installation. Yet another possibility is to puncture one of the double-walled tubes (or otherwise remove friction-reducing means). This

will prevent any revolving action since both are required due to the presence of the bulkhead as well as the cable. The double-walled tube that remains intact may contain a compressed gas (or be inflated) and therefore able to expand to compensate for the contraction of the punctured tube.

A telecommunications splice case **41** is shown in FIG. **12**, formed using the invention. Here a branch joint is shown between three cables **14**. The splice bundle **42** joining the cables can be seen to be of larger diameter than that of the cables **14**. In order mechanically to protect the splice bundle **42**, and optionally to provide a moisture vapour barrier, a liner **43** may be provided. The liner may for example comprise half-shells or may comprise a roll of material that is wrapped around the splice bundle **42**. In either case, the liner may have crowned ends, the fingers of which may be bent inwards to produce the tapered ends **44**. A double-walled tube **1** has been revolved into the position shown where it overlies the splice bundle and bridges the ends of the intact cable jackets, thereby forming an environmental seal around the otherwise exposed conductors, or optical fibres of the cable. A sealing material, for example a strip comprising a pressure-sensitive or curable adhesive, a gel or a mastic, may be provided around the cables **14**, and is shown cross-hatched. Where a branch splice, as shown, is to be sealed, a sealing material may be provided in the crutch region between the branching cables. Such sealing material is shown as stippling **45**.

FIG. **13** shows the use of the invention in joining together mechanically two elongate substrates, such as fluid supply lines, for example pipes **22**. A fluid proof seal can be obtained that allows some relative movement between the substrates, allowing vibrations to be absorbed, or allowing for some misalignment between the substrates. Sealing may be improved if desired by the provision of means such as the H-seal illustrated at **46**. Other solid or hollow substrates, for example scaffolding poles, may be held together end-to-end.

In FIG. **14**, a double-walled article **1** is used as part of a larger device, for example as an outlet **47** of a CATV splitter box **48**. The splitter box contains electrical contacts (not shown) for connection to the inner and outer conductors of a co-axial cable **49**. At the right hand side of the drawing a double-walled article **1** is shown in position, for example mechanically fixed or bonded to an outlet of the splitter box **48**. The cable **49** is simply pushed home, which causes the article **1** to revolve allowing the cable **49** to engage the electrical contacts within the box. The article **1** makes an environmental seal but may allow the cable easily to be withdrawn. At the left hand side of splitter box **48**, a cable **49** is shown inserted into an outlet. In this case, an article **1** is prepositioned over the cable **49** so that it can be revolved into a position, where it will make a seal to the outside of the outlet **47**. Where the box **48** extends further above and below its outlet **47** as drawn, the article may be provided with a circumferential flange (for example having the shape of a high voltage shed) or other means which will engage a surface of the box **48** and help to seal or to hold the article in place. We have suprisingly found that the article **1** is able to ride up sharp transitions, such as that from the cable to the outlet, without difficulty. It does this by collapsing concertina-like at its end, thus forming its own step up which it can ride.

FIG. **15** shows the invention used to hold elongate substrates together mechanically. In this case a cable harness **50** is made by holding together its component conductors **51**. The side branches **52** may be covered by installing double-walled articles **1** over their ends as indicated by the arrows. The regions **53** between the branches may be covered by revolving an article **1** over a branch as indicated at **54** and then back again. The invention may also be used to hold together other substrates for example ropes, pipes, scaffolding poles or cables, even of widely differing diameters.

FIGS. **16** to **19** show the use of the invention for delivery of an object onto a substrate. A double-walled tube **1** is used.

In FIGS. **16***a* to **16***d*, an elastomeric tube **55** is being delivered on to a cable for the purpose of covering a splice therein or repair of a jacket thereof, etc.

In FIG. **16***a* a tube **55** is positioned over one end of article **1**, optionally by folding inwards, or otherwise collapsing that end **56** of the article as shown. The other end **57** of the article **1** is revolved onto the substrate. An axial force is applied as shown by the arrow in FIG. **16***b* to cause further revolving action of the article **1**, bringing the tube **55** onto the substrate. Tube **55** may comprise an elastomeric material and may initially have an inside diameter smaller than the diameter of the substrate. In this case, the revolving action just described will cause the tube **55** to be radially expanded. A sealing material may provide an improved environmental seal between the tube **55** and the article **1** and/or between the article **1** and the substrate. Such a sealing material may have been previously applied to any of the surfaces involved, for example as a tape applied around the substrate.

The situation depicted in FIG. **16***b* may represent the installed product, the tube **55** reinforcing a seal provided by the article **1**.

The revolving action may however be continued as shown in FIGS. **16***c* and **16***d*. Here the tube **55** is carried by the outer wall of the article **1** until it reaches its end and is then turned inside-out. It is shown half inside-out in FIG. **16***c*. Further revolving action results in the article **1** overlying the tube **55**, as shown in FIG. **16***d*. Again, this situation may represent the installed product, or alternatively, the article **1** could be removed by yet more revolving action to leave the tube **55** alone on the substrate.

The present invention also allows an object **58** to be moved from one position to another on a substrate, or to be removed from a substrate, simply be reversal of the above procedure. This is true even if the article had to be radially expanded to apply it. Heat-recovered articles, by contrast, are often damaged by attempts to remove them, and in any case they cannot simply be reused.

FIGS. **17***a* to **17***d* show the use of the invention in delivering high-voltage sheds **32** onto a cable **14**. The technique used is analagous to that explained above in connection with the elastomeric tube **55**.

The shed **32** is preferably of an elastomeric material and has a center hole slighly smaller in diameter than the diameter of the cable **14**. The shed comprises a central, generally axially oriented, tubular base and a radially extending flange. Application of an axial force to the article **1** in the direction shown by arrow **58** carries the shed **32** onto the cable **14**. As shown in FIGS. **17***b* and **17***c*, the axially extending base is carried by the article **1** into contact with the cable **14**, and is inverted so that it is on the opposite side of the radially extending flange. The final assembly can be left as

shown in FIG. 17b with the shed on the article, or the shed can be left deposited directly on the cable by removing the article 1 in the direction shown by the arrow in FIG. 17c. Generally the concave surface of the shed should face vertically upwards.

FIGS. 18a and 18b, shown in cross-section delivery of a shed 32 having a plurality of radially extending flanges 59 onto an electrical cable 14. FIGS. 18a and 18b also demonstrate how an article such as a shed 32 can be placed on a substrate such as a cable 14 at a preselected position. The preselected position is identified by a dashed line 60 in FIGS. 18a and 18b. The shed 32 is placed on the exterior of the article 1 and the article 1 is placed over the exterior of the cable 14. The relative positions between the shed 32, article 1 and cable 14 are chosen so that the distance between the forward end of the shed 32 and the forward end of the article 1, represented by distance X in FIG. 18a, is equal to the distance between the forward end of the article 1 and the position 60, represented by distance Y in FIG. 18a. Thus when distance X equals distance Y, the shed is carried onto the cable to position 60, at which point the shed reaches the end of the article 1.

FIGS. 19a to 19d demonstrate the use of the present invention for placing a porcelain or glass housing 61 or other non-expandable object over a terminated cable or other substrate 14. Outdoor terminations frequently use an outer insulating housing 61 made from porcelain or glass. The housing 61 normally has an internal tubular opening and has radially extending external flanges 59 for shedding moisture The space between the housing 61 and the cable 14 is preferably filled, especially with a non-ionizing material.

In FIG. 19a, the cable 14 has an outer conductive layer 25, an insulating layer 13 below the conductive layer, and an internal electrical conductor 15 to which is attached lug 62. An article 1 is shown in FIG. 19b placed over the lug 62 and the porcelain housing 61 is placed over the other end of the article 1. An axial force is applied to the article 1 in a direction shown by the arrows, so that the porcelain housing 61 is carried onto the cable 14. The inside diameter of the housing 61, is larger than the outer diameter of the insulating layer 13 of the cable 14. In the assembly shown in FIG. 19c, the article 1 is directly on the cable 14, with its forward end extending over the conductive layer 25, and the porcelain insulating housing 61 is on top of the article 1. The article 1 fills in the space between the insulating ceramic housing 61 and the cable 14, and a large filling volume within the double wall may be desirable here. The article 1 may also provide stress grading at the terminated end of the cable 14. Stress grading may be required in higher voltage cables due to the removal of the conductive layer 25. As discussed above, the article 1 can be made stress grading by incorporating conductive material into the material of its walls or within the double wall as a friction-reducing or separating means, or by applying to an exterior surface a stress-grading sealing material.

A second article 63 can be used as a gasket to seal together the cable 14, the insulating housing 61, and the first article 1. The second article 63 may also lock the housing and the first article 1 in place. This can be effected by preplacing the second article 63 on the cable 14 before the insulating housing is carried onto it. The installed configuration is shown in FIG. 19d.

Although generally the length of the object 61 to be placed on a substrate 14 is no more than twice the length of the article 1, the article can be longer than this. For example, an article 1 may have wrapped longitudinally around it an elongated tubular sleeve The sleeve may be pictured attached at one end to an "end" of the article. The sleeve is then turned inside-out around the outside of the article (or outside-in to lie within the centre of the article). Such inversions may be repeated more than once. When the assembly of the article and the sleeve is revolved in one direction onto a substrate, the sleeve is continually placed on the substrate with the exposed end of the sleeve being layed on the substrate first. Thus a single article may be used to lay a long length of insulating tubing or other object onto a long substrate such as an electrical cable in a fast and easy operation. If the article is revolved in the opposite direction, the sleeve remains wrapped around the article, and the two together move along the substrate without the sleeve unwrapping.

A plurality of objects may be placed on a substrate adjacent, overlapping, or one on top of another, with one or more articles. Moreover, the object need not be tubular. For example the object may have an opening that is at least partially slot-shaped. In a further alternative, the material of the object adjacent its opening may be plastically deformable or it may be being formed by sponge rubber or the like, while the remainder of the object may be made of a rigid material such as a rigid polymeric material.

Further, the circumference of an opening of the object may be larger than the outer circumference of the substrate. For example, the opening of the object may be oval in cross-section with a minor axis shorter than the diameter of the substrate so that expansion of the article along its minor axis occurs as it is carried onto the substrate by the application.

Also, rather than the object comprising a deformable material, it may have arms or other parts adjacent or defining an opening therein that can be moved for example cantilevered so that they spread apart as the object is carried onto the substrate.

In conclusion it is stated that the invention provides any double-walled structure, method of covering a substrate such as a cable or a pipe for environmental, mechanical, chemical, or electrical reasons, lubrication system, covered substrate and kit including a double-walled structure, having any one of the features disclosed herein. For example, any one or more of the double-walled configurations, wall materials, dimensions, physical, electrical or chemical properties, friction-reducing means, sealing materials, method of use or of manufacture, and fields of use may be selected.

The invention specifically provides an article comprising a double-walled tube that can be continuously revolved along an elongate member by relative sliding motion between the two walls of the double wall, substantially without relative sliding motion between a wall adjacent the member and the member, the double wall:

(a) defining a closed region between its two walls;

(b) having between its two walls a friction-reducing means comprising a solid or a liquid; and

(c) comprising an elastomeric material;

such that if said liquid is non-setting, the volume of the closed region is such that when the article surrounds a substrate of a size such that its wall adjacent the substrate is under a positive tensile strain the average separation between its walls is less than 10 times its average wall thickness; and

the tube being of such a configuration that it will buckle rather than revolve if subjected to an axial compressive force applied between an outer wall at one extreme end and an inner wall at an opposite extreme end.

The invention also provides a method of covering a supply line, which comprises revolving onto the supply line an article having a double wall and being capable of continuously revolving along an elongate member by relative sliding motion between the two walls of the double wall substantially without relative sliding motion between a wall adjacent the member and the member.

The invention also provides a method of environmentally sealing a substrate, which comprises: forcing a sealing material against the substrate by revolving over the substrate an article comprising a double-walled tube such that tension within a wall of the tube acts on the sealing material; said double-walled tube being capable of continuously revolving along an elongate member by relative sliding motion between the two walls of the double wall substantially without relative sliding motion between a wall adjacent the member and the member.

The invention also provides an article comprising: a double wall; and a friction-reducing means between the two walls of the double wall and comprising a non-newtonian liquid having a viscosity at a shear rate of 1 reciprocal second that is greater than 5 times the viscosity at a shear rate of 100 reciprocal seconds; the article being capable of being applied to a substrate by relative sliding motion between the two walls substantially without relative sliding motion between a wall adjacent the substrate and the substrate.

We claim:

1. A double wall tubular article comprising: a double wall defining a closed region between its two walls; and a friction reducing means between the two wall of the double wall and comprising a siliconc oil, a semi-solid material or a particulate solid; the article being capable of being applied to a substrate by relative sliding motion between the two walls substantially without relative sliding motion between a wall of the article adjacent the substrate and the substrate; wherein the volume of the closed region is such that when the article surrounds a substrate of a size such that its wall adjacent the substrate is under a positive tensile strain, the average separation between its walls is less that 10 times its average wall thickness.

2. An article according to claim **1**, in which the friction-reducing means is capable of maintaining lubrication under a pressure gradient of 27 kPa per cm.

3. An article according to claim **1**, in which the average separation between the two walls is less than 10 times the average wall thickness.

4. An article according to claim **1**, in which the double wall comprises an elastomeric material.

5. An article according to claim **4**, in which the elastomeric material has a second modulus at 100% elongation of less than 24.7 Kg per cm^2 (350 psi), and an elongation to break of at least 100%.

6 An article according to claim **4**, suitable for providing electrical insulation, in which the elastomeric material has a resistivity of greater than 10^{10} ohm.cm.

7. An article according to claim **6**, in which the elastomeric material is substantially non-tracking

8. An article according to claim **6**, suitable for providing electrical stress grading, in which the elastomeric material has a specific impedance of 10^7 to 10^{19} ohm.cm at 60 Hz.

9. An article according to claim **6**, suitable for providing a conductive layer in a high voltage cable termination or joint, in which the elastomeric material has a resistivity of less than 10^4 ohm.cm.

10 An article according to claim **6**, in which the elastomeric material has a tear resistance of at least 90N per cm (40 lb. per linear inch).

11 An article according to claim **1**, having the form of a double-walled tube, the double wall defining a closed region between its two walls.

12 An article according to claim **3**, in which the double wall together with the friction reducing means has an electrical strength of at least 50 kV per cm.

13. An article according to claim **1**, in which the article is applied to the substrate over an end thereof by engaging one wall of the double wall and the substrate, and applying an axial compressive force between the substrate and the outer wall at a position less than 7 cm from said end of the substrate.

14. A method of covering a substrate, which comprises revolving onto the substrate a double wall tubular article comprising (a) a double wall defining a closed region between its two walls and (b) a friction-reducing means between the two walls of the double wall and comprising a silicone oil, a semi-solid material or a particulate solid; the article being capable of being applied to said substrate by relative sliding motion between the two walls substantially without relative sliding motion between a wall of the article adjacent the substrate and the substrate wherein the volume of the closed region is such that when the article surrounds a substrate of a size such that its wall adjacent the substrate is under a positive tensile strain, the average separation between its walls is less than 10 times its average wall thickness.

15. A method according to claim **14**, in which the substrate comprises two pipes that are thereby joined by the article.

16. A method according to claim **14**, in which the substrate comprises a cable splice or termination that is thereby environmentally or electrically protected by the article.

17. A method applying a hollow object around a substrate, which comprises interposing between the object and substrate a double wall tubular article comprising (a) a double wall defining a closed region between its two walls and (b) a friction-reducing means between the two walls of the double wall and comprising a silicone oil, a semi-solid material or a particulate solid; the article being capable of being applied to a substrate by relative sliding motion between the two walls substantially without relative sliding motion between a wall of the article adjacent the substrate and the substrate wherein the volume of the closed region is such that when the article surrounds a substrate of a size such that its wall adjacent the substrate is under a positive tensile strain, the average separation between its walls is less than 10 times its average wall thickness.

18. A method of forming a duct seal between a duct and a substrate that passes therethrough, which comprises revolving along the substrate to a position within the duct an article comprising a double-walled tube that can be continuously revolved along an elongate member by relative sliding motion between the two walls of the double wall, substantially without relative sliding motion between a wall adjacent the member and the member, the double wall tubular article comprising (a)

a double wall defining a closed region between its two walls and (b) a friction reducing means between the two walls of the double wall and comprising a silicone oil, a semi-solid material or a particulate solid, the article being capable of being applied to the substrate by relative motion between the two walls substantially without relative sliding motion between a wall of the article adjacent the substrate and the substrate wherein the volume of the closed region is such that when the article surrounds a substrate of a size such that is wall adjacent the substrate is under a positive tensile strain, the average separation between its walls is less the 10 times its average wall thickness.

19. A method of covering a supply line, which comprises revolving onto the supply line a double wall tubular article comprising (a) a double wall defining a closed region between its two walls and (b) a friction reducing means between the two walls of the double wall and comprising a silicone oil, a semi-solid material or a particulate solid; the article being capable of being applied to the supply line by relative sliding motion between the two walls substantially without relative sliding motion between a wall of the article adjacent the supply line and the supply line wherein the volume of the closed region is such that when the article surrounds a substrate of a size such that its wall adjacent the supply line is under a positive tensile strain, the average separation between its walls is less than 10 times its average wall thickness.

20. A method according to claim 19, in which environmental protection, electrical protection, and/or thermal insulation or conductivity is provided at least partly by said article.

21. A method according to claim 20, in which electrical insulation is provided around a conductor, said article comprising a material having a resistivity of greater than 10^{13} ohm cm.

22. A method according to claim 20, in which electrical stress-grading is provided around a high voltage conductor splice or termination, said article comprising a material having a specific impedance of 10^7-10^{10} ohm cm at 60 Hz.

23. A method according to claim 20, in which electrical shielding is provided around a conductor splice or termination, said article comprising a material having a resistivity of less than 10^4 ohm cm.

24. A method according to claim 20, in which electrical protection is provided around a high voltage conductor splice or termination, said article comprising a material having an electrical strength of at least 50 kV per cm.

25. A method according to claim 19, in which environmental protection, electrical protection and/or thermal insulation or conductivity is provided at least partly by an object delivered to the supply line by said article.

26. A method according to claim 25, in which said object comprises a shed.

27. A method according to claim 25, in which environmental protection, electrical protection and/or thermal insulation or conductivity is supplemented by a sealing material.

28. A method according to claim 27, in which said revolving forces the sealing material against the supply line.

29. A method according to claim 19, in which the supply line comprises two pipes that are mechanically secured end to end by said article.

30. A method according to claim 19, in which said article comprises a material having a tear resistance of at least 90N per cm (40 lb. per linear inch)

31. A method according to claim 19, in which the article comprises a material that is substantially non-tracking.

32. A method according to claim 19, in which environmental protection is provided around a cable splice or termination, said article comprising a material having a maximum water absorption less that 2% by weight.

33. A method according to claim 19, in which environmental protection is provided around a telecommunications cable splice, said method additionally comprising positioning around said splice a liner over which the article is revolved.

34. A method according to claim 19, in which the supply line comprises a multi-core cable, said method additionally comprising forming a cable block by delivering a curable composition to the cable core.

35. A method according to claim 19, in which the double wall comprises one or more elastomeric materials and is of such a size relative to that of the supply line that said revolving involves stretching the material of the wall adjacent the supply line by an average of 10-150% based on its unstressed dimension.

36. A method according to claim 19, in which a cable is sealed to an outlet in a housing through which it enters the housing, said article being attached to the outlet, and said revolving being caused by inserting the cable into the outlet.

37. A method according to claim 19, which additionally comprises radially slitting the outer wall and then causing shear or peel between the two walls in the absence of revolving, such that each of said walls is caused to lie adjacent the supply line.

38. A method according to claim 19, in which at least one wall of said double-walls comprises at least two layers having different electrical properties.

39. A method according to claim 19, in which the article is revolved onto an end of the supply line by engaging one wall of the double wall and said end of the supply line, and applying an axial compressive force between the supply line and the other wall at a position less than 7 cm from said end of the supply line.

40. A method of environmentally sealing a substrate, which comprises: forcing a sealing material against the substrate by revolving over the substrate an article comprising a double walled tube such that tension within a wall of the tube acts on the sealing material; said double walled tube having a friction-reducing means between the two walls of the double wall and comprising a silicone oil, a semi-solid material or a particulate solid; the article being capable of continuously revolving along an elongate member by relative sliding motion between the two walls of the double wall substantially without relative sliding motion between a wall of the article adjacent the member and the member wherein the volume of the closed region is such that when the article surrounds a substrate of a size such that its wall adjacent the member is under a positive tensile strain, the average separation between its walls is less than 10 times its average wall thickness.

41. A method according to claim 40, in which the article is revolved over an end of the substrate by engaging an inner wall of the tube and said end of the substrate, and applying an axial compressive force between the substrate and an outer wall of the tube at a position less than 7 cm from said end of the substrate.

42. A method according to claim 40, in which said double wall comprises one or more elastomeric materials having a secant modulus at 100% elongation of less than 27.4 Kg per cm^2 (350 p.s.i.) and an elongation to break of at least 100%.

43. A method according to claim 40, in which the sealing material comprises a mastic, or a gel, or a curable or pressure sensitive adhesive.

44. A method according to claim 43, in which the sealing material comprises a gel having a cone penetration value of 100-350 (10^{-1} MM).

45. A method according to claim 43, in which the sealing material comprises a gel having an ultimate elongation of at least 200%.

46. A method according to claim 40, in which the sealing material is applied to the substrate in the form of a tape.

47. A method according to claim 46, in which the tape comprises a perforate material impregnated with the sealing material.

48. A method according to claim 40, in which the sealing material comprises a non-silicone polymer having an olefinic unsaturated content of less than 10 mole per cent and having 0.1-3 cross-links per weight average molecules; a liquid dispersed in the polymer in an amount of 20-95% based on the weight of the liquid and the polymer; and optionally a filler dispersed in the liquid and/or polymer.

49. A method according to claim 40, in which the substrate comprises a high voltage conductor splice or termination and the sealing material has a specific impedance of 10^7-10^{10} ohm cm at 60 Hz.

50. A method according to claim 40, in which the double-walled tube comprises a material having a resistivity of greater than 10^{10} ohm cm.

51. A method according to claim 40, in which the substrate is of non-uniform or non-circular cross-section and said sealing material has a cone penetration of 10-350 (10^{-1}MM), said revolving causing the sealing material substantially to conform to the surface of the substrate.

52. A method according to claim 40, in which the substrate comprises a cable branch, the sealing material being caused substantially to conform to the crutch region between the branching cables.

* * * * *

Reference 6

US005540465A

United States Patent [19]

Sisk

[11] Patent Number: 5,540,465

[45] Date of Patent: Jul. 30, 1996

[54] **PIPE, VALVE AND/OR TEE COUPLER**

[76] Inventor: David E. Sisk, 7353 Hillsboro Rd., Bonne Terre, Mo. 63628

[21] Appl. No.: 283,828

[22] Filed: Aug. 1, 1994

[51] Int. Cl.[6] F16L 17/025

[52] U.S. Cl. 285/365; 285/367; 285/420; 285/112

[58] Field of Search 24/270, 112; 285/365, 285/367, 409, 420; 292/265.69, 247

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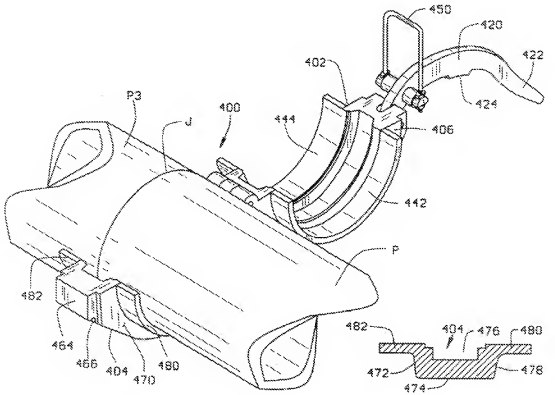
Primary Examiner—Eric K. Nicholson
Attorney, Agent, or Firm—Paul M. Denk

[57] **ABSTRACT**

A pipe coupler for interconnecting pipes and components together, for transferring bulk and fluid materials, and useful for connecting sections of pipe-end-to-end. The coupler connects grooved pipe to ground pipe, smooth pipe to grooved pipe or smooth pipe to smooth pipe. Also tees, valves, and pipe sections can be secured together. The coupler has an adjustable bail that can be adjusted to assure a tight seal despite any wear. The coupler also eliminates any gaps that may trap material and lead to cross-contamination of subsequent loads.

8 Claims, 6 Drawing Sheets



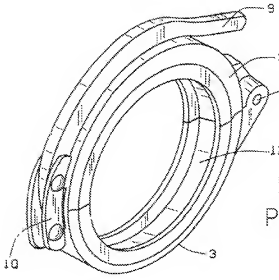


FIG. 1
PRIOR ART

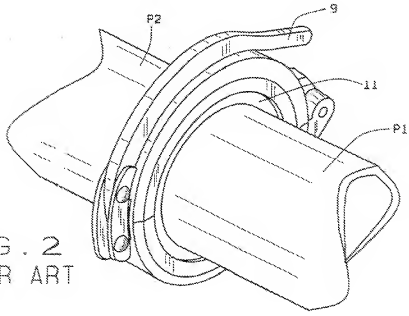


FIG. 2
PRIOR ART

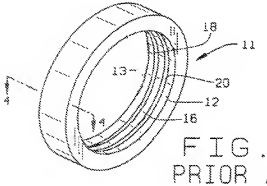


FIG. 3
PRIOR ART

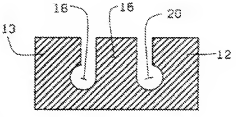


FIG. 4
PRIOR ART

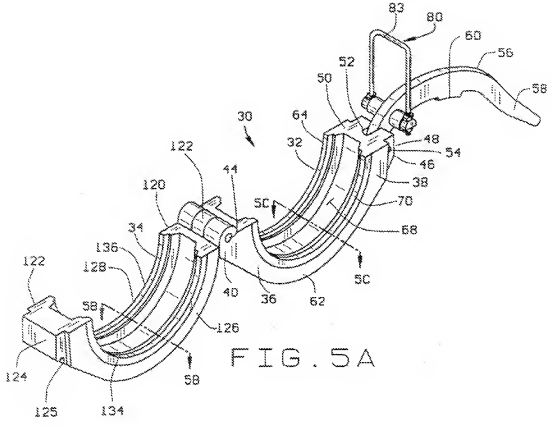


FIG. 5A

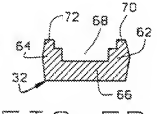


FIG. 5B

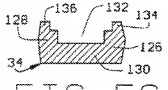


FIG. 5C

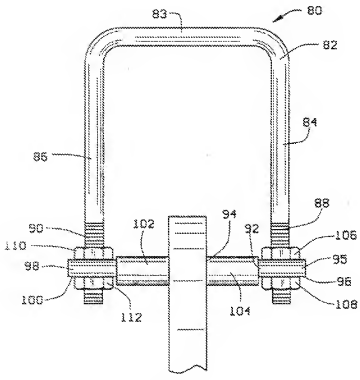

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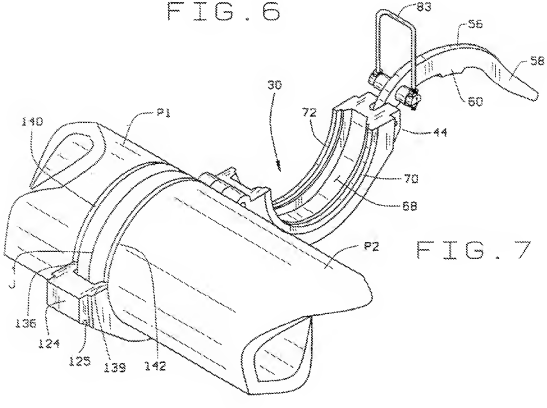
FIG. 6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P1
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FIG. 7

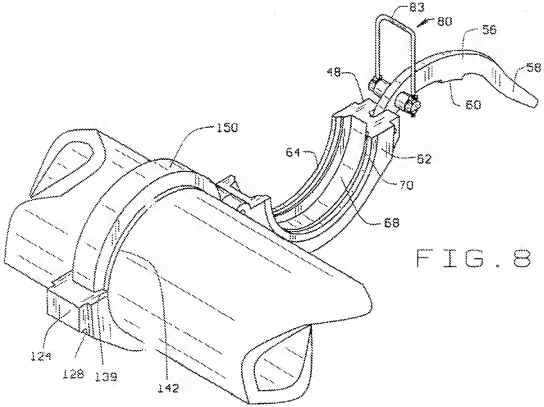

FIG. 8

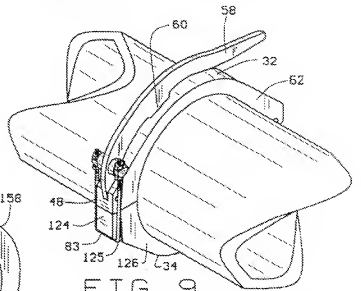

FIG. 9

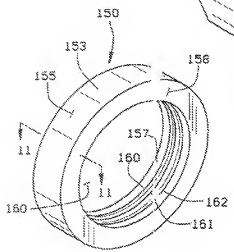

FIG. 10

FIG. 11

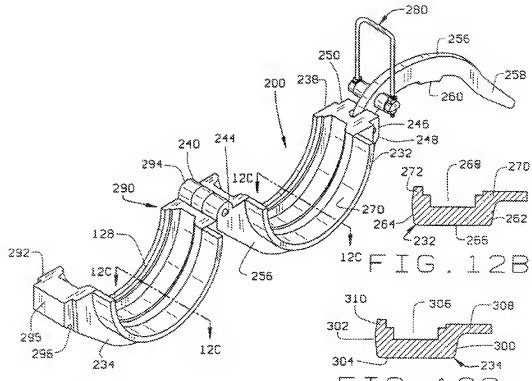

FIG. 12A

FIG. 12B

FIG. 12C

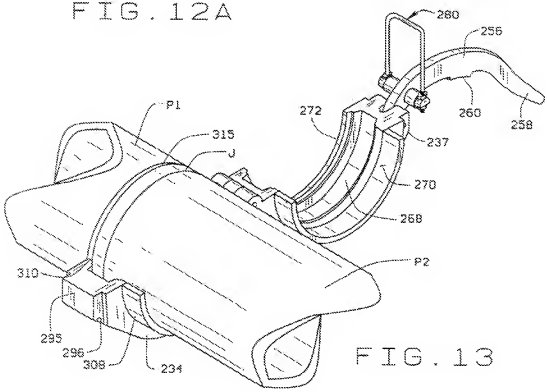

FIG. 13

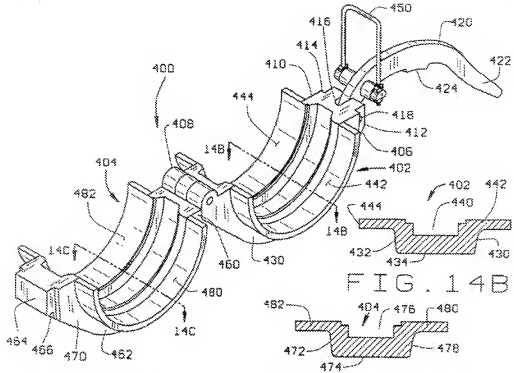

FIG. 14A

FIG. 14B

FIG. 14C

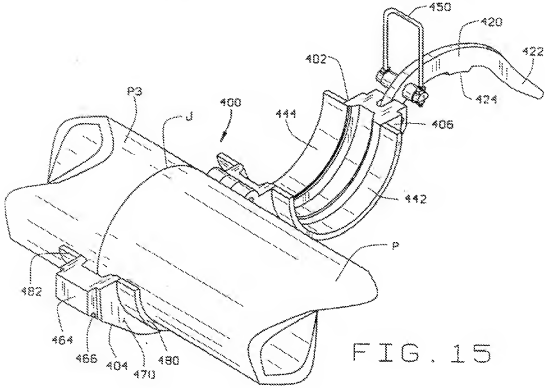

FIG. 15

PIPE, VALVE AND/OR TEE COUPLER

BACKGROUND OF THE INVENTION

This invention relates generally to pipe couplers, more specifically to an adjustable coupler with an improved gasket.

Clamps and couplers used to connect sections of pipe, end-to-end, are known to the art. Such clamps often are employed to connect sections of pipe or hopper tees on tank cars. In certain applications, particularly in dry bulk hauling, the integrity of the seal at the pipe connections is critical in preventing cross contamination of the products sequentially hauled in the tank cars. Often pellets or powders are hauled in the tank cars. The pellets or powders are unloaded through gravity gates valves or hoppers located on the bottom of the tank cars. Hopper tees attached to the bottom of the hopper are connected to collection pipes. Sometimes a vacuum is employed through the pipe to facilitate the emptying of the dry bulk products. All of the dry bulk product must be removed to prevent contamination of subsequent loads. For example, if the hauler is carrying black plastic resin beads, all of the black plastic resin must be removed from the car, as well as the hopper and piping, to prevent contamination of a subsequent white or other colored plastic resin load. Another example is the transportation of edible white flour. If flour is trapped in the tank car or the piping system and develops mold, a subsequent flour load will be exposed to the mold. Obviously, there can be cross contamination of bulk liquids as well as bulk dry loads. Such contamination can destroy a load, force its disposal, and at heavy costs.

It is known in the art that contamination can occur at the point of coupling the pipes and the hopper tees. Prior art clamps employ gasket seals that can trap product. FIGS. 1–4 illustrate components of a typical prior art clamp. Prior art clamp **1** is a typical overcenter clamp having two semi-circular sides **3** and **5** connected by hinge **7**. A conventional overcenter lever **9** and cam **10** clamping means is used to draw the two halves tightly together to surround the clamp joint. A deformable gasket **11** lines the interior groove **12** of clamp **1**. A deformable gasket of the prior art type is shown in FIGS. 3 and 4. As can be seen, gasket **11** has outer walls **13** and **14** with a center member **16** designed to deform and press against the pipe joint. Gaps **18** and **20** between the respective sides and the middle member create areas in which material, for example, dry bulk material such as plastic resins or flour, can become entrapped. It is nearly impossible to remove such material once it is lodged deep in the gaps **18** and **20**.

There are other problems other than cross contamination associated with prior art clamps such as clamp **1**. Such prior art clamps have no means for adjustment. The clamp, even when new, can be difficult to open and close. Lever **9** and cam **10** wear during use until clamp **1** loosens and fails. This type of clamp must be changed and discarded, leading to waste and increased costs.

Furthermore, such clamps of the type shown in FIG. **1** are made of cast iron and mild steel parts. Clamp **1** can corrode from exposure to the environment. Once corroded, the clamp is nearly impossible to remove from the pipe P or hopper T. The user must pry lever **9** with a pry bar or length of small diameter pipe. Then the user must beat two halves **3** and **5** apart with a hammer to separate them.

Finally, such clamps are not versatile in that they are not easily adapted to connect different pipe sections together.

For example, the clamp may be needed to connect two sections of smooth pipe, connect two section of grooved pipe or connect a smooth pipe to a grooved pipe. Prior art clamps may work to connecting similar pipes, but do not accommodate different styles of pipe.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide a pipe coupler having an adjustable clamping bail that can be adjusted to accommodate changes in tolerances due to wear.

Yet another object of the invention is to provide a pipe coupler that can be adapted to connect sections of grooved pipe end-to-end, connect a grooved pipe to a smooth pipe end-to-end, or connect two sections of smooth pipe, end-to-end.

Another object of the present invention is to provide a pipe coupler employing a gasket seal that compresses flush to the pipe sections leaving no spaces or gaps to collect material.

Still another object of the present invention is to provide a gasket seal that provides greater sealing surface and the pipe joint.

Still another object of the present invention is to provide such a pipe coupler made from long lasting corrosion-resistant material.

Yet another object of the present invention is to provide a pipe coupler that requires no tools to couple or uncouple.

Still another object of the present invention is to provide a pipe coupler that is durable, long lasting, economical to manufacture.

In accordance with the invention, briefly stated, a pipe coupler is provided having an adjustable clamping bail and a gap sealing gasket. The coupler has a first and second, semi-circular clamping arms which, together, define an annular opening to encircle the respective ends of the pipes to be joined. The arms are connected with a hinge. The first arm has a cam with a lever. An adjustable clamping bail is connected to the lever. The second arm has a boss to engage the bail when clamped on pipe. The first and second clamping arms each have a generally U-shaped profile defined by a bottom wall and first and second opposed side walls. A sealing gasket seats in a groove between the walls and is compressed by the two halves when the coupler is closed. In one embodiment of the invention each of the clamping arm side walls has a raised rib thereon. The rib engages an annular groove formed in a end of a section of pipe to connect two grooved sections of pipe together. In another embodiment, the first side wall on each arm has a raised rib that engages a grooved pipe and the second side wall on each arm has a smooth flange to engage a smooth end of pipe. This embodiment is used to connect a smooth pipe to a grooved pipe. In a third embodiment, each arm side wall has a smooth flange formed thereon to engage a smooth pipe to connect two smooth ends of pipe together. The inner wall of the gasket has raised ridges with one ridge positioned to seal the pipe joint. As the coupler is installed, it compresses the gasket around the pipe at the joint and spreads the ridges to fill up the inside diameter of the clamp to provide a greater sealing surface at both the pipe joint. The gasket has no gaps or grooves to collect material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a prior art pipe clamp;

FIG. 2 is an isometric view of a prior art pipe clamp applied to two sections of pipe;

FIG. 3 is an isometric view of a prior art pipe clamp gasket;

FIG. 4 is a cross sectional view of the prior art gasket taken along lines 4—4 of FIG. 3;

FIG. 5A is an isometric view of one illustrative embodiment of the pipe coupler of the present invention;

FIG. 5B is a cross sectional view taken across lines 5B—5B of FIG. 5A;

FIG. 5C is a cross sectional view taken along lines 5C—5C of FIG. 5A;

FIG. 6 is an enlarged, front plan of the bail assembly of the pipe coupler of the present invention;

FIG. 7 is an isometric view of the pipe coupler of FIG. 5, partially applied to two sections of pipe;

FIG. 8 is an isometric view of the pipe coupler of FIG. 6 with an improved gasket of the present invention in place;

FIG. 9 is an isometric view of the pipe coupler of FIG. 7 applied to two sections of pipe;

FIG. 10 is an isometric view of the coupler gasket of the present invention;

FIG. 11 is a cross-sectional view taken along lines 11—11 of FIG. 10;

FIG. 12A is an isometric view of another illustrative embodiment of the pipe coupler of the present invention;

FIG. 12B is a cross-sectional view taken along lines 12B—12B of FIG. 12A;

FIG. 12C is a cross-sectional view taken along lines 12C—12C of FIG. 12A;

FIG. 13 is an isometric view of the pipe coupler of FIG. 12A partially applied to two sections of pipe;

FIG. 14A is an isometric view of another illustrative embodiment of the pipe coupler of the present invention;

FIG. 14B is a cross-sectional view taken along lines 14B—14B of FIG. 14A;

FIG. 14C is a cross-sectional view taken along lines 14C—14C of FIGS. 14A, and

FIG. 15 is an isometric view of the pipe coupler of FIG. 14A partially applied to two sections of pipe.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An illustrative embodiment of a pipe coupler of the present invention is indicated generally by reference numeral **30** in FIG. 5 and 6. Coupler **30** has a first clamping arm **32** and a second clamping arm **34**. The respective clamping arms are generally semi-circular in profile. First clamping arm **32** has a first end **36** and a second end **38**. A hinge portion **40** is integrally formed at the first end. A conventional bale and pin **44** function as the hinge portion. There is a mount **46** at the second end. Mount **46** has a first wall **48** and a second wall **50** defining a space **52**. A hole **54** is formed centrally in cam wall **48** and there is a corresponding aligned hole (not shown) in wall **50**. A *pin* (not shown) extends through the holes to form a lever hinge as will now be explained.

A bail lever **56** is pivotally attached to mount **46**. Lever **56** is generally arcuate in profile and has a handle section **58** at a first end and a hole (not shown) at a second end. As stated above, the pin **54** is inserted in the mount holes and extends through the hole in the second end of lever **56** to form a hinge. A raised boss **60** is integrally formed on the interior curve of lever **56**. As can be seen in FIG. 5B, first clamping arm **32** has a generally U-shaped cross-section. Arm **32** has a first side wall **62**, an opposed second side wall **64** and a bottom or base wall **66**. The respective walls define a groove **68** to seat a gasket, as will be explained below. First side wall **62** has a raised rib **70** integrally formed thereon. Rib **70** extends the length of wall **62**. Second side wall **64** has a raised rib **72** formed thereon. Rib **72** extends the entire length of wall **64**.

An adjustable bail assembly **80** is pivotally attached to bail lever **56**. Bail assembly **80** is shown in greater detail in FIG. 6. Bail assembly **80** has a generally U-shaped bail **82** with a horizontal section **83** and opposed arms **84** and **86**. Bail arm **84** terminates in a threaded portion **88**. Arm **86** terminates the threaded portion **90**. A pivot rod **92** extends through a hole (not shown) in bail lever **56**. A first end **95** of rod **92** has a flat side **96**. A second end **98** of rod **92** has a flat side **100**. A pair of spacers **102** and **104** are positioned on rod **92** on each side of lever **56**. Spacers **102** and **104** can be made out of teflon, plastic, harden rubber or any other appropriate wear-resistant material. A first tightening nut **106** is threadly engaged on threaded portion **88** above rod end **95**. Second tightening nut **108** is threadly engaged on the threaded portion **88** below rod end **95**. A third tightening nut **110** is threadly engaged on the threaded portion **90** of arm **86** above rod end **98** and a fourth tightening nut **112** is threadly engaged on threaded portion **90** below rod end **98**. It should be noted, at this point, that bail **80** and rod **92** as well as the other components, other than the spacers, are made from a harden steel or other appropriate material. The construction of bail assembly **80** allows for the adjustment of bail **80** relative to lever **54**. Bail assembly **80** can be tightened by the various tightening nuts to properly adjust the tension on the bail when the coupler is fastened in place even if there are changes in tolerances due to wear.

Second clamping arm **34** has a first end **120** and a second end **122**. There is a conventional hinge portion **122** on the first end **120** and designed to cooperate with hinge portion **40** to form a secure hinge. The hinge allows the clamping arms to pivot relative to each other for opening and closing.

A boss **124** is integrally formed at the second end of clamping arm **34**. Boss **124** has a groove **126** formed therein to seat horizontal portion **83** of bail **82** when the coupler is closed and locked. As can be best seen in FIG. 5C, arm **34** has a generally U-shaped profile nearly identical to that of arm **32**. Arm **34** has a first side wall **126**, a second side wall **128** and a bottom wall **130**. The respective walls define a groove **132** to seat a gasket as will be explained below. First side wall **126** has a raised rib **134** integrally formed thereon. Rib **134** extends the length of wall **126**. Second side wall **128** has a raised rib **136** formed thereon. Rib **136** extends the length of wall **128**.

Coupler **30** is designed to join together two sections of pipe having annular grooves cut in the surface of the respective pipe sections near the joint as best illustrated in FIGS. 7–9 pipe sections P1 and P2 have annular grooves **140** and **142** formed therein near joint J. The respective raised ribs **70**, **72**, **134** and **136** seat in the corresponding grooves **140** and **142** when the clamping arms **32** and **34** are pivoted about the hinge toward each other. The respective clamping arms encircle joint J. A gasket **150**, which will be described in greater detail hereinafter, is seated in grooves **68** and **132** and surrounds joint J. For clarity of illustration, FIG. 7 shows the arrangement of the coupler **30** relative to the pipe sections without gasket **150** in place. FIG. 8 illustrates the arrangement of the coupler and the pipe with gasket **150** in

place. As shown in FIG. 9, horizontal section 83 of bail 82 engages groove 125 on boss 124. Lever 54 is pushed down until boss 60 abuts arm 32. Bail 82 is pulled into groove 125, and lever 56 locks down, securing couple 30 in place. Gasket 150 is compressed under the respective clamping arms, as to completely seal joints J. The configuration of the bail 82 and the groove 125 on boss 124 is such as to allow a lesser leverage pressure required to manipulate the lever 56 to lock and unlock the coupler during its usage and applications.

Gasket 150 is shown in greater detail in FIGS. 10 and 11. Gasket 150 is made from a deformable, impervious material such as rubber, or polymer. Gasket 150 has an annular body 153 with an outer surface 155 and an inner surface 157 with a material thickness 158 inbetween. Inner surface 157 defines internal bore 160. Inner surface 157 has three symetrical ridges 160, 161 and 162 integrally formed as a serration like surface thereon. The middle ridge 161 is positioned to align with pipe joint J. Since gasket 150 is made of a deformable material, the ridges 160–162 compress and flatten when the coupler is closed and locked. The compression flattens and spreads ridges 160–162 and seals joint J. There are no gaps.

Another illustrative embodiment of the coupler of the present invention, is shown in FIGS. 12A–13 and is indicated, generally, by reference numeral 200. Coupler 200, as will be appreciated by those skilled in the art, is designed to connect two sections of pipe, one section having a smooth end surface and the other having an annular groove cut in the surfaces. Coupler 200 has a first clamping arm 232 and a second clamping arm 234. The respective clamping arms are generally semi-circular in profile. First clamping arm 232 has a first end 236 and a second end 238. A hinge portion 240 is integrally formed at the first end. A conventional hole and pin 244 function as a hinge. There is a cam 246 at the second end. Cam 246 has a first wall 248 and an opposed second wall 250. A pin (not shown) extends through the holes to form a lever hinge, as will now be explained. A bail lever 256 is pivotally attached to cam 244. Lever 256 is generally arcuate and profile having a handle portion 258 at a first end and a hole (not shown) at a second end. As stated above, pin 244 extends through the holes in the hinge portion and through the hole (not shown) in the second end of the lever 256 to form a hinge for the pivotal movement of bail lever 256. A raised boss 260 is integrally formed on the interior curvature of lever 256.

As can be seen in FIG. 12B, first clamping arm 232 has a generally U-shaped cross-section. Arm 32 has a first side wall 262, a second side wall 264 and a bottom wall 266. The respective walls define a groove 268 to seat a gasket, as previously explained relative to coupler 30. First side wall 262 has an integral flange 270 which protrudes outwardly from side wall 262 and also extends the length of wall 262. Second side wall 264 has a raised rib 272 integrally formed thereon. Rib 272 extends the entire length of wall 264. An adjustable bail assembly 280 is pivotally attached to bail lever 256. Bail assembly 280 is identical in construction and function to bail 80, as previously described with reference to coupler 30 above.

Second clamping arm 234 has a first end 290 and a second end 292. There is a conventional hinge portion 294 on first end 290 that cooperates with hinge portion 240 to form a conventional hinge, as previously explained. A boss 295 is integrally formed at the second end of arm 234. Boss 295 has a groove 296 formed therein to seat the bail when the coupler is locked, as previously described. As can best seen in FIG. 12C, arm 234 has a generally U-shaped profile which is a mirror image of that of arm 232. Arm 234 has a first side wall 300, second side wall 302 and a bottom wall 304. The respective walls define a groove 306 to seat a gasket. Obviously, in usage, a gasket as previously described, will fit within the coupler. First side wall 300 has an integral flange 308 integrally formed thereon. Flange 308 protrudes out from wall 300 and extends the length of wall 300. Second side wall 302 has a raised rib 310 formed thereon. Rib 310 extends the length of wall 302.

Coupler 200 is designed to join together segments of pipe, one having an annular groove machined in the surface near the joint and the other having a smooth surface, as illustrated in FIG. 13. Pipe section P1 has an annular groove 315. The raised ribs 272 and 310 seat in the groove 315. Flange 270 and 308 protrudes outwardly from the respective arm walls and abut the smooth end of pipe P2. Coupler 200 is shown without a gasket in FIG. 13 for clarity of illustration. However, in use, a gasket, as illustrated in FIG. 10, is placed around pipe joint J and seats in the respective grooves between the respective clamping arm side walls.

FIGS. 14A through 15 shown another illustrative embodiment of the pipe coupler of the present invention, for use in coupling two ends of smooth and ungrooved pipe sections together. Indicated generally by reference numeral 400. Coupler 400 has a first clamping arm 402 and a second clamping arm 404. The respective arms are generally semi-circular in profile. First clamping arm 402 has a first end 406 and a second end 408. First end 406 has a conventional hinge arrangement as previously described with reference to the other illustrative embodiments. There is a cam 410 at the second end. Cam 410 has a first wall 412 and a second wall 414 defining space 416. A hole 418 is formed centrally in cam 48 and there is a corresponding hole (not shown) in cam wall 414 (not shown). A pin (not shown) extends through the hole to form a lever hinge as previously explained. A bail lever 420 is pivotally attached to cam 406. Lever 420 is generally arcuate and profile, as previously explained, and has a handle section 422. As stated above, a hole in the second end of the lever fits into cam 406 in a hinge-like arrangement. Raised boss 424 is integrally formed on the internal curve of the lever.

As can been seen in FIG. 14B, first clamp arm 402 has a generally U-shaped cross section. Arm 402 has a first side wall 430, a second side wall 432 and a bottom wall 434. The respective walls define a groove 440. Groove 440 is disposed to seat a gasket as previously explained. First side wall 430 has an integral flange 442 formed thereon and protruding outwardly from side wall 430. Flange 442 extends the length of wall 430. Second side wall 432 has an integral flange 444 formed thereon, protruding outwardly from wall 432 and extending the length of wall 432. The coupler 400 has an adjustable bail assembly, shown generally at 450, which is identical to bail assembly 80 previously described. Second clamping arm 34 has a first end 460 and a second end 462. There is a conventional hinge type apparatus connecting the respective first ends of the clamping arms as previously described with reference to the other embodiments. A boss 464 is integrally formed on the second end of arm 404. Boss 464 has a groove 466 to seat the bail when the coupler is locked as previously described. As can be best seen in FIG. 14C, arm 404 has a generally U-shaped profile nearly identical to that of arm 402. Arm 404 has a first side wall 470, a second side wall 472 and a bottom wall 474 the respective walls define a groove 476 for the seating of a gasket as previously explained. First side wall 670 has an integral flange 480 formed thereon and protruding out from side wall 470. Flange 480 extends the length of wall 470. Side wall 472 has a flange 482 integrally formed thereon and

protruding outwardly from the wall. Coupler **400** is designed to join two sections of smooth pipe, as illustrated in FIG. **15**. Coupler **400** is shown without a gasket for clarity of illustration. The respective flanges **442**, **444**, **480** and **480** abut the smooth surfaces of pipes P3 and P4 to secure them together.

It will be appreciated by those skilled in the art that various changes and modifications can be made in the coupler without departing from the scope of the appended claims. Furthermore, the various couplers are shown connecting sections of pipe. It will be understood that the coupler is intended to join sections of pipe to hopper tees. Both grooved and smooth, as well as connecting sections of conventional pipe.

Therefore, the foregoing description and accompanying drawings are intended to be illustrative only and should not be construed in a limiting sense.

I claim:

1. A coupler for connecting two sections of pipe, end-to-end, comprising:

a first and second semi-circular clamping arm, each said clamping arm having a first end portion and a second end portion;

each said first end portion connected together to allow for pivotal movement of said arms;

a mounting means on the second end portion of said first arm;

a bail lever attached to said mounting means, said bail lever having sides, and a pivotal spacer means extending from each side of the bail lever and being mounted to said bail lever;

a bail assembly attached to said extending pivotal spacer means, said bail assembly having a generally U-shaped configuration, and capable of pivoting generally in alignment with a plane formed between the ends of the two contiguous pipe sections when coupled;

said bail assembly being adjustable in its attachment to the spacer means;

a boss on the second end of said second arm for accepting said bail assembly;

each said first and said second arms having a generally U-shaped cross section with a first side wall and a second side wall defining a groove for seating of a gasket;

said first and second side walls of each said arm having a raised rib formed thereon, each said rib disposed to seat in an annular groove formed approximate an end of a section of pipe.

2. The invention of claim **1** wherein said bail assembly is adjustable in its connection with the spacer means to accommodate changes in tolerances due to wear of said coupler.

3. The coupler of claim **1** wherein said clamping arms and said lever are formed from an aluminum alloy.

4. The coupler of claim **1** wherein said bail assembly is made of stainless steel.

5. The coupler of claim **1** having a gasket seated in said groove, said gasket having a generally annular shape with an outer and an inner wall, said inner wall defining a bore, said outer wall being smooth so as to seat in said groove and said inner wall having a plurality of ridges.

6. A coupler for connecting two sections of pipe, end-to-end comprising:

a first and second semi-circular clamping arm, each said clamping arm having a first end portion and a second end portion; each said first end portions connected together to allow for pivotal movement of said arms;

a cam means on the second end portion of said first arm;

a lever attached to said cam means, said lever having sides, and a pivotal spacer means extending from each side of the lever and being mounted thereto;

a bail assembly pivotally attached to said spacer means, said bail assembly having a generally U-shaped configuration;

said bail assembly capable of pivoting generally in alignment with a plane formed between the ends of the two contiguous pipe sections when coupled;

said bail assembly being adjustable in its attachment to the spacer means;

a boss on the second end of the second arm for accepting said bail assembly;

each said first and said second clamping arm having a generally U-shaped cross-section with a first side wall and a second side wall defining a groove for seating a gasket;

said first side wall of each arm having a smooth flange formed thereon for the sealing of a smooth end of a section of pipe and said second side wall of each arm having a smooth flange formed thereon for the seating of a smooth end of a section of pipe.

7. A coupler for connecting two sections of pipe or a section of pipe to an adjustable hopper T, end-to-end comprising:

a first and second semi-circular clamping arm, each said clamping arm having a first end portion and a second end portion:

each said first end portions connected together to allow for pivotal movement of said arms;

a cam means on the second end portion of said first arm, and a lever pivotally attached to said cam means,

said lever having sides, and a pivotal spacer means extending from each side of the lever and being mounted to the said lever;

a bail assembly attached to said extending pivotal spacer means, said bail assembly having a generally U-shaped bail, and capable of pivoting generally in alignment with a plane formed between the ends of the two sections of pipe or a section of pipe to a hopper T when coupled;

said bail assembly being adjustable in its attachment to the spacer means;

a boss on the second end of said second arm for accepting said bail;

each said first and said second clamping arm having a generally U-shaped cross-section with a first side wall and a second side wall defining a groove for seating a gasket;

said first side wall of each said arm having a raised rib formed thereon, each rib disposed to seat in an annular groove in an end of a section of pipe and said second side wall of each arm having a smooth flange formed thereon for the seating of a smooth end of a section of pipe.

8. The invention of claims **1**, **6** or **7**, wherein said bail assembly being generally U-shaped, formed having a pair of arms each terminating in a threaded portion, the threaded portion of each bail arm extending through said spacer means, and an adjustable fastener securing to each bail arm and capable of adjusting the U-shaped bail with respect to the lever to which it pivotally attaches for adjusting the tensioning on the bail when the coupler is fastened in place around the pipe ends.

* * * * *

Reference 7

US005642907A

United States Patent [19]

Dole

[11] Patent Number: 5,642,907

[45] Date of Patent: Jul. 1, 1997

[54] **END FITTING FOR SPRINKLER SYSTEM**

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[73] Assignee: **Victaulic Company of America**, Easton, Pa.

[21] Appl. No.: **650,192**

[22] Filed: **May 20, 1996**

[51] **Int. Cl.**[6] **F16L 17/035**

[52] **U.S. Cl.** **285/112**; 285/901; 285/148.19; 285/148.23; 239/593

[58] **Field of Search** 285/175, 112, 285/176, 177, 901; 239/589, 592, 593, 594, 598

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Attorney, Agent, or Firm—Abelman, Frayne & Schwab

[57] **ABSTRACT**

An end fitting for a water supply pipe of a sprinkler system is in the form of a hollow tubular body having an internal cavity which progressively decreases in cross-sectional area from an end of the body attached to the supply pipe to an opposite end of the body in the manner of a convergent nozzle, in order to enhance the pressure of water available to a sprinkler head attached to the fitting at a position remote from the pipe end.

9 Claims, 3 Drawing Sheets

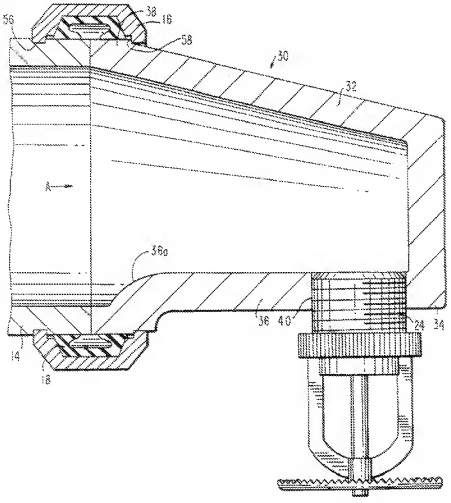


FIG. 1
PRIOR ART

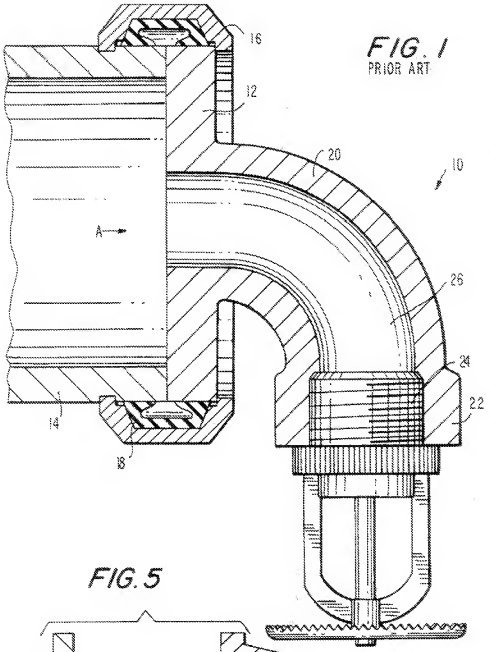
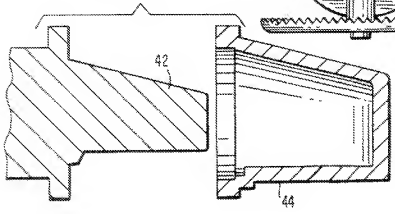


FIG. 5



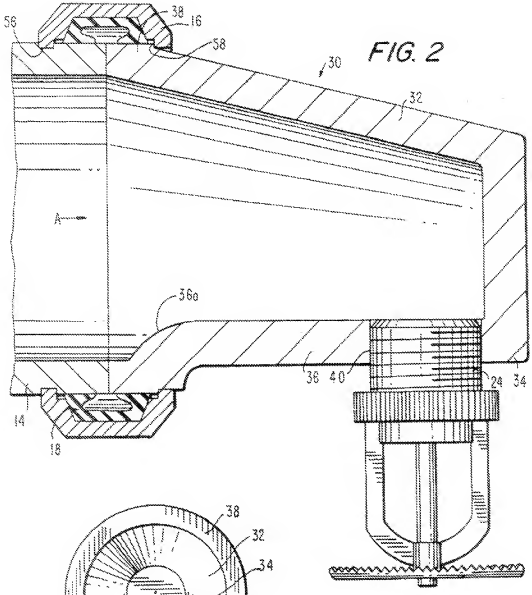


FIG. 2

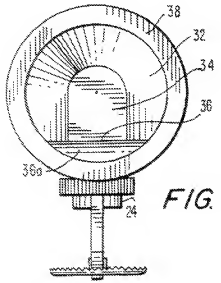


FIG. 4

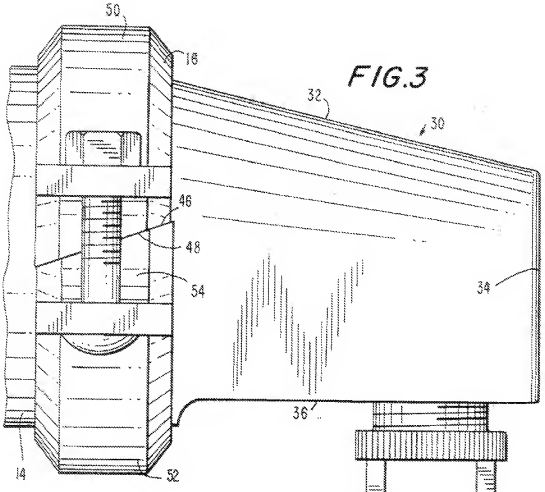


FIG.3

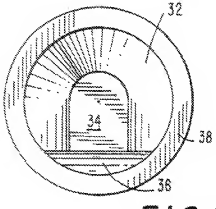


FIG.6

END FITTING FOR SPRINKLER SYSTEM

FIELD OF THE INVENTION

This invention relates to an end fitting for use at the terminal end of a conduit employed in the fabrication of a sprinkler system.

Typically, such a system will be comprised of pipes having an internal diameter of 1.5" to 2.5", that at spaced positions along their length are provided with sprinkler heads that extend perpendicular to the longitudinal axis of the associated pipe. The sprinkler heads can be attached to the associated pipe in any one of a number of manners, such as well known in the art. Threaded saddles can be provided on the pipe for securement of the respective sprinkler heads, the saddles communicating with the pipe interior by means of a bore extending radially of the pipe axis. Alternatively, the fitting for support of the sprinkler head can be brazed, welded or otherwise secured to the pipe, the fitting having a bore communicating with the pipe interior.

Such pipelines of sprinkler systems, of necessity require an end closure for the remote end of the pipe. This can be provided by an end fitting in the form of a cap providing an end closure for the pipe, which has been secured to the pipe in any convenient manner, such as by threading onto the pipe, or, by the use of a segmented pipe coupling in the manner later described.

However, the provision of an end cap, in turn involves a wastage of pipe. Rather than to provide a blank end cap, and in the interest of cost savings, it is highly desirable that the end cap be eliminated, and, that the end fitting itself provide a mounting for the terminal sprinkler head of that pipeline.

Throughout the following description, reference is made to the use of segmented pipe couplings for use in the assembly of the sprinkler system. It will be understood that instead of segmented pipe couplings screw threaded couplings and the like can be used.

The threading of the pipe ends and the threading of the end fittings must, however, be effected prior to assembly of the sprinkler system, this involving additional time and consequential cost, with the added additional expense of hand-assembling the end fittings onto the respective pipes, and effecting the necessary caulking operations on the threads of the pipes and fittings. While the use of segmented pipe couplings is preferred, it is to be understood that the use of threaded pipes and end fittings is included in this invention.

Segmented pipe couplings are comprised of two or more coupling segments of arcuate form having keys on their inner periphery for engagement within a circumferential groove cut in the pipe end, or otherwise formed, for example, by a rolling operation.

The respective coupling segments are positioned over a seal member of an elastomeric material that has been positioned over the pipe ends, subsequent to which traction bolts securing the respective coupling segments to each other are tightened down so bring the respective coupling segments into clamping engagement with the pipes, or, in the event that an end fitting is employed, into clamping and sealing engagement with a radially extending end flange of the end fitting.

Segmented pipe couplings are available which provide a flexible connection between the pipe ends, or the end of the pipe or the end fitting, and, also are available as coupling which provide a rigid connection between the respective pipe ends or the pipe end and end fitting. A flexible coupling

is one which permits the longitudinal axis of the respective pipes to angle and rotate relative to each other, with additional capability of moving axially relative to each other to a limited extent. A rigid coupling is one which inhibits such angular and rotational movements or axial movements of the respective pipes, or the pipe and end fitting of present concern. Thus, the use of rigid couplings is preferred.

BACKGROUND OF THE PRIOR ART

As previously mentioned, it is known to form a pipeline over length, and, then to close the end of the pipe by an end cap or end fitting, the end cap either being threaded onto the pipe end and sealed, or, secured thereto by a segmented pipe coupling.

This, however, represents a wastage of materials in that the pipe must terminate axially beyond the last sprinkler head in the assembly.

This problem previously has been addressed, an end fitting being known, as is illustrated FIG. 1 of the accompanying drawings, which is comprised of radially extending annular cap, the central opening of which communicates with an outlet pipe, that of necessity, must extend at exactly in a 90° angle for the outlet thereof to extend perpendicular to the pipe axis, the pipe terminating in an internally threaded end collar within which the threaded shank of a sprinkler head is secured.

Typically, the pipes of such pipelines have a minimum internal diameter of between 1.5" and 2.5". Also, typically, the outlets of such end fittings must have a bore of at least 0.5" in order to provide adequate water flow to the sprinkler head. Further, the sprinkler must be assembled onto the pipe fitting at a distance sufficient from the pipe to permit the installation of a sprinkler guard on the sprinkler head.

This requires that the radius of curvature of the outlet pipe extending from the end flange of the end fitting must be on a radius of curvature at least equal to the radius of the pipe.

The end fitting, however, is not nearly as robust as the pipe itself. Thus, impact on the end fitting during assembly of the sprinkler system can cause bending or breakage of the outlet pipe of the end fitting. Additionally, the end fitting presents an appearance which is less than attractive.

A major disadvantage with such known end fittings is that while the end flange of such fittings must block off a surface area of 4.9 square inches, the outlet pipe itself only presents an outlet opening of 0.20 square inches. Thus, water progressing along the pipe to the sprinkler head, when the sprinkler head is active, encounters a radial end wall, which extends perpendicular to the axis of the pipe, and, which represents a major source of pressure losses, turbulence and eddy currents, this in turn resulting in a loss in the pressure of fluid exiting the central aperture. Further, as the fluid exiting the central aperture, must itself be changed in direction by 90°, further pressure losses are encountered in the outlet pipe to the sprinkler head. Additionally, pressure losses are caused by the contraction loss from the pipe diameter to the central aperture diameter.

These losses in dynamic and static pressure result in the sprinkler head at the end of the pipe being incapable of operating as efficiently as the other sprinklers in the line. Regulatory and insurance requirements require a determined minimum flow from any one of the sprinkler heads, regardless of the location of that sprinkler head in the sprinkler system. This in turn mandates an oversizing of the supply pipe with the additional cost thereon.

SUMMARY OF THE INVENTION:

The invention has for its object to significantly reduce dynamic and static pressure losses in the end fitting, thus permitting downsizing of the supply pipe.

Another object of the present invention is to provide a cast end fitting that does not require a core in the casting of the end fitting, thus substantially reducing the cost of manufacturing the end fitting.

A further object of the present invention is to provide an end fitting that will guide assembled sections of pipeline and sprinkler heads that have been pre-assembled and pre-tested, by providing a slide or skid at the leading end of the pipeline that will automatically "find" holes through which the pipeline is to be passed, and pass over obstructions in the path of movement of the pre-assembled pipeline and sprinkler heads.

Another object of the invention is to eliminate the relatively weak and unattractive radii sing of known end fittings, thus to provide an end fitting of greater structural strength, and that is less prone to damage than known end fittings.

According to the present invention, an end fitting for a pipeline of a sprinkler system preferably is configured as a hollow frustum of a cone having a radially extending end flange, and a closure at the smaller end of the frustum.

The frustum itself is not completely circular, except at the end flange, but includes a flat surface that extends substantially parallel to the pipe axis when the end fitting is installed on a pipe end, thus to provide a planar surface on which a sprinkler head can be seated, a threaded bore being provided extending through the planar surface, permitting threading of the threaded shank of the sprinkler into the fitting.

The advantages of this construction are that firstly the flow of water passing longitudinally through the pipe and through the sprinkler head does not meet with an abrupt end face of the end fitting, but instead is directed into the end fitting in a relatively quiescent manner that significantly reduces eddy currents and turbulence.

The water entering the end fitting passes interiorly frustum from the larger to the smaller diameter end thereof in the substantial absence of pressure losses due to contraction. While this has the effect of retarding the volume per unit time of water flow, it also has the beneficial effect of increasing the dynamic pressure in the water flow as it proceeds from the larger diameter end of the frustum towards the smaller diameter end thereof.

In this manner eddy currents and turbulence are suppressed, while at the same time the dynamic pressure of the water flow is increased as it passes through the frustum from the larger end thereof to the smaller end thereof, the pressure increase acting to compensate for the pressure losses that have occurred in the end fitting as a consequence of surface friction, residual eddy currents and turbulence.

The dynamic pressure of the water flow at the smaller end of the frustum thus can be held closely equivalent to the dynamic pressure existing in the pipeline.

The relatively quiescent water flow eventually encounters the end wall of the fitting, at which time its forwards progress is blocked by the end wall. This results in an increase in the pressure of the water available to sprinkler head, and which counteracts the dynamic pressure loss resulting from the 90° rotation of the water flow, in preparation for its exiting through the ejection nozzle of the sprinkler head.

The increase in dynamic pressure in the water flow, as offset by the surface friction, residual eddy currents and turbulence and change of direction of the water flow, results in the water flow exiting the standard sprinkler nozzle being very closely equivalent the water flow exiting through each other of the standard sprinkler nozzles, thus assuring equal volume and coverage of the ejected water exiting the sprinkler head at the end of the pipeline.

DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the accompanying drawings, which illustrate a preferred embodiment of the invention, and, in which:

FIG. **1** is a longitudinal cross-section through a prior art end fitting;

FIG. **2** is a longitudinal cross-section through an end fitting according to the present invention;

FIG. **3** is a front elevation;

FIG. **4** is a view of the end fitting of the present invention taken in the direction of the arrow **4** in FIG. **2**; and

FIG. **5** is illustrative of the respective male and female members of a mold employed for casting the end fitting of the present invention.

FIG. **6** is an end view of the end fitting of the present invention.

DESCRIPTION OF THE PRIOR ART

FIG. **1** shows an fitting indicated generally at **10** which is comprised of a radially extending annular flange **12** having an outer diameter closely approximating that of the outer diameter of a supply pipe **14** to which the end fitting **10** is attached by means of a known segmented pipe coupling **16**, the joint between the annular flange **12** and the supply pipe **14** being sealed by an elastomeric seal **18**, in a manner well known in the art.

The annular flange **12** of the end fitting is cast integrally with a right-angle elbow **20**, the elbow **20** terminating at its end in an internally threaded boss **22**, in which a sprinkler head **24** is threadedly secured.

As will be apparent, the end fitting of FIG. **1**, which is made by a casting operation, involves a two-part mold, in order to mold the flange and the right-angled elbow, and also requires the insertion into the mold of a core, in order to provide the internal passage **26** in the elbow, the requirement for a core in turn carrying with it the requirement for subsequently removing the core from a cast end fitting, and, the subsequent internal threading of the threaded boss **22**.

Each of those operations represent a significant cost factor in the manufacture of the end fitting.

In terms of its effectiveness, the end fitting the prior art is encumbered with numerous disadvantages.

Water flow through the pipe **14**, must first encounter the radial end face of the annular flange **12**, which extends substantially perpendicular to the pipe axis. In the event that the pipe has an internal diameter of 2.5", and the internal passage **26** of the right-angled elbow **20** has a diameter of 0.5", such as is common in the art, then, the water flow in the direction of the arrow A is almost completely obstructed the cross-sectional area of the pipe interior representing 4.9 square inches, whereas the outlet provided by the internal passage **26** represents only 0.20 square inches, this leaving a completely blocked area of 4.70 square inches.

On the other hand, a high velocity flow of water in the direction of the arrow A and through the internal passage **26** is required at the time the sprinkler head **24** is in an opened condition. This high velocity flow of water concentrically of the pipe **14** has the effect of inducing axial flow towards the annular flange **12** of the surrounding of volume of water, which only can be dissipated by a reverse flow of the surrounding volume of water. This results in a pressure loss

in the water flowing into the internal passage **26** caused by the reverse flow, eddy currents and other tubulences in the pipe **14**, the loss in pressure also being accompanied by contraction losses and frictional restraint on the water entering the internal passage **26**.

By configuring the end fitting to have an annular end flange **12**, a first source of pressure loss is present. The water entering the internal passage **26** is then subjected to a second pressure loss resulting from the change in direction of the water flow, accompanied by frictional skin effects and further turbulence and eddy currents as the exiting water flow passes through the right-angled elbow **20**.

The culmination these pressure losses is that the water pressure available to the sprinkler head **24** is lower than that available at other sprinkler heads along the line, which, if a standard sprinkler head is employed as a sprinkler head **24**, will result in a lower output volume and reduced dispersion throw of the sprinkler head **24** as compared with other sprinkler heads along the line.

Regulatory and insurance requirements require a determined minimum flow from any one of the sprinkler heads along the line. Thus, for consistency of water dispersion and flow volume, the supply pipe is required to be oversized in order to provide an equivalent water flow and dispersion throw to the other standard sprinkler heads in the line.

A part from being visually unattractive, the sprinkler head of the prior art is less than robust and is susceptible to damage by impact on the right-angled elbow **20**, which in turn must be of relatively massive construction capable of withstanding such impacts, this in turn increasing the weight and the cost of the end fitting.

Further, the right-angled elbow must be of a radius equal to the radius the pipe to which the end fitting is attached in order for the sprinkler head to extend perpendicular to the pipe axis. The right-angled elbow and its threaded boss **22**, is thus required to extend beyond the outer diameter of the pipe **14**. This presents an inconvenience in increasing the distance that the sprinkler head must extend radially of the pipe axis and also represents an inconvenience in the event that the pipeline is to be preassembled prior to its installation, and then threaded into its supporting brackets.

As will be apparent, it is advantageous to be able to assemble a complete line of sprinkler heads onto the pipe **14** prior to the installation of the pipe and sprinklers into the sprinkler system. This permits testing of the assembly prior to its incorporation into the sprinkler system at an elevated location.

DESCRIPTION OF THE INVENTION

The end fitting of the present invention overcomes these problems by eliminating the major sources of pressure losses. Firstly, the annular flange **12** of the prior construction is eliminated in its entirety, thus eliminating a major source of pressure losses. Secondly the right-angled elbow **20** is eliminated in its entirety, thus eliminating the further pressure losses occurring in the right-angled elbow **20**, and additionally eliminating the mechanical weakness of such a right angled elbow.

According to the present invention, the end fitting, indicated at **30** is in the form of a frustum of a cone, the larger end of which is attached to the pipe **14** by use of a segmented pipe coupling **16**, the end fitting comprising an arched side wall **32**, and a planar rectilinear side wall **36**, that terminate in an end wall **34**.

The side walls **32** and **36** commence in an annular end wall **38** adapted to abut the end of the pipe **14**, and be secured thereto by the pipe coupling **16**, thus to provide a continuation of the bore of the pipe **14**.

As will be apparent, disturbances caused in the water flow by the annular flange **12** of the prior art end fitting are eliminated in their entirety, the end fitting of the present invention permitting a quiescent water flow in the direction of the arrow A without turbulence.

The water flow then passes into the interior of the end fitting **30**, which is configured as a convergent nozzle. This has the effect increasing the pressure of the water flow as it passes from the open annular end wall **38** towards the end wall **34**, i.e., instead of a pressure loss being incurred as in the right-angled elbow **20** of the prior art construction, a compensating pressure increase is generated, and this, in the substantial absence of any eddy currents or turbulence.

By virtue the compensating increase in the dynamic pressure of the water flow as it progresses from the open end **38** towards the closed end **34**, the static pressure available at the closed end **34** is maintained closely equivalent to that in the pipeline **14** itself.

The water flow is then required to change direction in order for it to pass through the sprinkler head **24**, which will occasion a pressure loss. That pressure loss is, however, the same as that encountered by each other sprinkler head along the line.

In this manner, the water pressure and the available flow rate to the sprinkler head **24** is held comparable to that of the water pressure and flow rate available to any other sprinkler head along line, thus enabling the sprinkler head **24** to be a standard sprinkler head having the same characteristics as any other sprinkler head along the line.

The sprinkler head is attached to the planar and rectilinear side wall **36** of the end fitting **30** by threading it into a threaded bore **40** provided in the end fitting **30** subsequent to the casting of the end fitting **30**, this itself constituting a minor manufacturing operation.

Of major importance is that the end fitting **30** of the present invention can be cast in the total absence of a core member, such as is required in the casting of the prior art end fitting. This presents a major cost saving in the production of the end fitting **30** of the present invention, which as diagrammatically illustrated in FIG. **5** can be cast employing a male mold **42** configured to provide the internal conical surfaces of the end fitting **30**, and an outer female mold **44** configured to contour external surfaces of the end fitting **30**.

The respective molds **42** and **44** are devoid of any re-entrant surfaces, and, thus need not be destroyed after a casting operation. The respective molds thus can be permanent molds employed for casting a continuous series of end fittings **30**, this representing a further economy in the cost of manufacture of the end fittings.

Modern casting techniques permit the casting of the end fittings **30** in the final finish form, thus eliminating the need for finish machining. Also, as the respective molds interfit, instead of being arranged in abutting relationship as required in production of the end fitting of the prior art, the exterior of the end fitting **30** according to the present invention is devoid of any flashings or splines that must be removed by a grinding operation. Further, as the requirement for a core is eliminated, the necessity for subsequently removing that core also is eliminated, the total resulting being that a fully finished end fitting according to the present invention can be produced in a single operation in a highly economical manner, the only requirement being to subsequently provide the threaded bore **40**.

FIG. **4** is an end view of the fitting **30** taken in the direction of the arrow **4** in FIG. **2**, and more clearly

illustrates the manner in which the annular end wall **38** converges into the frusto-conical side wall **32** and the planar rectilinear side wall **36**, and also the terminating end wall, each of which combined to provide the surfaces of frustum of a cone, and, each of which is devoid of any surfaces that would produce eddy currents and turbulence in the water flow, with the possible minor exception of the step **36a** extending cord-wise of the frustum, and which is essential in order to provide the planar rectilinear side wall **36**.

Preferably the end fitting **30** is attached to the pipe **14** employing a self-adjusting pipe clamp and coupling if the type disclosed in U.S. Pat. No. 4,639,020 issued Jan. 27, 1987, that coupling being capable of clamping the end fitting **30** into abutting relation with the end of the pipe **14** in a manner inhibiting axial, angular or rotational movements of the end fitting **30** relative to the pipe **14**.

A segmented pipe coupling as disclosed in the U.S. patent includes coupling segments that are provided with oppositely angled end faces **46** and **48** at the respective ends of the coupling segments **50** and **52**. When clamped together by a traction bolt **54**, the ends of the coupling segments **50** and **52** are caused to move oppositely relative to each other along the axis of the pipe, in order to bring the keys of the coupling segments into clamping engagement with the side walls of the groove **56** formed in the pipe, and also into clamping engagement with a step **58** formed exteriorly of the end fitting **30** in concentric relation with the annular end wall **38** of the end fitting **30**. In this manner the end fitting is immobilized against angular, rotational or axial movements relative to the pipe.

An advantage of the structure of the present invention is that the sprinkler head **24** can be positioned at a smaller distance from the pipe axis then is possible according to the prior art. Additionally, as the end fitting **30** converges away from the pipe end, the outer surface of the end fitting **30** can be employed as a skid or guide for use in the positioning of the assembled pipeline assembly subsequent to its assembly at a location remote from the installation point, the assembled pipeline having been rotated through 180° to enable such an operation, the pipeline assembly subsequent to installation then being rotated to 180° to its initial position as illustrated in FIGS. **2** and **3**.

Through out the description, reference has been made to the use of segmented pipe couplings for use in securing the end fitting **30** to the end of the pipe **14**. Alternative manners of securement can be employed, for example, the threading of the pipe end and the provision of a correspondingly threaded bore at the entrance end of the end fitting **30**.

What is claimed is:

1. An end fitting for a water supply pipe of a sprinkler system, said end fitting including:

an elongate hollow body member having a side wall;

attachment means at one end of said hollow body member for attaching said hollow body member to an end of a said supply pipe; and,

a closure for an opposite end of said elongate hollow body member;

said side wall converging from said one end of said hollow body member to said opposite end thereof to provide a bore of said hollow body member of progressively decreasing transverse cross-sectional area from said one end of said hollow body member to said opposite end thereof; and,

means for the attachment of a sprinkler head to said body member at a position spaced from said one end.

2. The end fitting of claim **1**, in which said side wall of said hollow tubular body member defines a longitudinal axis of said hollow body member, said attachment means being operative to secure said hollow body member to said pipe with said longitudinal axis of said hollow body member extending in parallelism with a longitudinal axis of said pipe.

3. The end fitting of claim **1**, in which said side wall, when viewed in transverse cross-section defines a continuous outer wall of a hollow cylinder and includes a rectilinear wall portion extending transverse to said longitudinal axis of said hollow body member.

4. The end fitting of claim **3**, in which said rectilinear wall extends longitudinally of said hollow body member in parallelism with said longitudinal axis of said pipe and includes an aperture spaced from said securement means permitting the passage of water in a direction perpendicular to said longitudinal axis of said hollow body member, and into a sprinkler head secured to said hollow body member.

5. The end fitting of claim **4**, in which said sprinkler head includes a threaded shank, which is received within a threaded bore providing said aperture in said rectilinear wall of said hollow body member.

6. The end fitting of claim **4**, in which said rectilinear wall defines a planar surface extending longitudinally and transversely of said longitudinal axis of said hollow body member.

7. The end fitting of claim **1**, in which an interior wall of said hollow body member defines a sector of a frustum of a cone, further including an end wall at said opposite end of said hollow body member providing said closure of said hollow body member.

8. The end fitting of claim **1**, in which said attachment means comprise a radially and outwardly extending flange of said hollow body member at said one end of said hollow body member.

9. The end fitting of claim **1**, in which said hollow body member defines a continuous inner wall devoid of re-entrant portions, and which extends in converging relation to said longitudinal axis of said hollow body member from said one end of said hollow body member to said opposite end thereof;

whereby, said hollow body member can be cast employing a male and female die alone in the absence of a core member.

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